

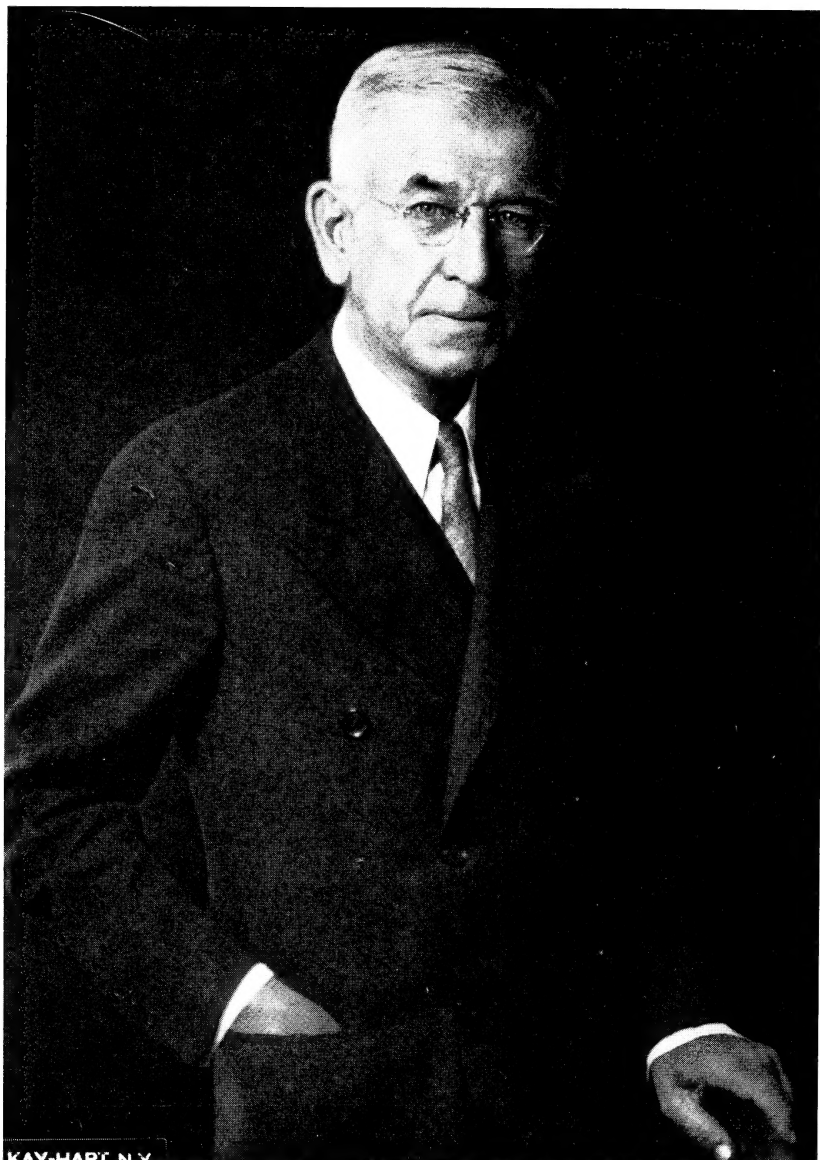




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(Photograph by Kay-Hart, N. Y.)

AVEN NELSON

Frontispiece to Volume 7, MADROÑO.

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MADROÑO

A WEST AMERICAN JOURNAL OF
BOTANY

VOLUME VII

1943 - - 1944



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To Aven Nelson, founder of the Rocky Mountain Herbarium, President, Emeritus, of the University of Wyoming, now in his eighty-fifth year—we dedicate this seventh volume of *Madroño*.

His is a life, rich in experience, rich in accomplishment! He pioneered both in the field of botany and horticulture in the Rocky Mountain and Great Basin regions. He effected the training and greatly influenced the lives of many students who have taken their places among the able botanists of our time.

Apart from his work as an educator his influence on the agriculture of the northern Rocky Mountains has been notable. He wrote many horticultural bulletins issued by the state of Wyoming and was among the first to urge the growing of apples as an agricultural crop in that area.

His great ability and kindly personality are reflected in his being appointed to serve as president of the University of Wyoming during the years 1917 to 1922, and, in 1935, being elected president of the Botanical Society of America. The genus *Anelsonia* Macbride and Payson and such species as *Salix Nelsonii* Ball, *Carex Nelsonii* Mackenzie, *Stipa Nelsonii* Scribner, *Delphinium Nelsonii* Greene and *Cirsium Nelsonii* (Pammel) Rydb. are among the many plants named in his honor.

We wish him good health and many more years of usefulness in his chosen field of study.

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\$ Botany

VOLUME VII

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THALICTRUM AMETRUM GREENE: AN INTERESTING NOMENCLATURAL CASE

LEON CROIZAT

The validity of *Thalictrum polycarpum* S. Wats. against the earlier *T. polycarpum* Loret, and the later *T. ametrum* Greene has been affirmed by Wheeler (Rhodora 40: 318-320. 1938) in a discussion which is exceedingly interesting under the standpoint of nomenclature. In this discussion Wheeler raises two issues, first, whether the parenthetic author must be indicated in every case; second, whether an earlier name can be duplicated, and if so under what conditions.

Lack of space makes it necessary for me to discuss here only one of these issues. Accordingly, I shall discuss the second, which is more important.

The first printed mention of *Thalictrum polycarpum* occurs in a paper by Loret (Bull. Soc. Bot. France 6: 16. 1859). To spare the reader the necessity of wading through Loret's stiff French, but doing violence to accepted bibliographical standards, I shall quote here as if in the original my own translation of this publication. Loret states: "I have collected in a hedge at Barcelonnette (Basses-Alpes) at the end of July 1851 an interesting *Thalictrum* which is quite noteworthy on account of its short-ovoid carpels, 9-12 to 14 being borne upon a single receptacle. This plant is close to, but differs appreciably from *T. Jacquinianum* Koch and *T. expansum* Jord. I believe this *Thalictrum* to be a new species, but, fearing to augment the confusion already prevalent in this genus, I merely bring this plant to the attention of the botanists who may have the opportunity of collecting at Barcelonnette, hoping on my part to see this plant again on the spot. If I were to be allowed to give this plant a name, I would gladly call it *T. polycarpum* or, better still, *T. multiflorum* (S'il m'était réservé de lui imposer un nom, je lui donnerais volontier celui de *Th. polycarpum* ou mieux *multiflorum*)."

The binomials of Loret have been disregarded by practically every author, with the exception of Lecoyer. In his monograph of *Thalictrum* (Bull. Soc. Bot. Belg. 24: 78-324. 1885), Lecoyer treats *T. polycarpum* as a synonym of *T. multiflorum* (op. cit., 304), which he places in the synonymy of *T. minus* L. Lecoyer adds (op. cit., 297) that *T. multiflorum* is "une forme non décrite" of *T. minus*, believing *T. multiflorum* to be a *nomen nudum* or a *nomen seminudum* which has *T. polycarpum* as its synonym.

Wheeler is of the opinion, on the contrary, that *T. polycarpum* and *T. multiflorum* "is an illegitimate name of the type known as a *nomen provisorium*," without specifying which one of these two binomials he interprets as the provisional name. I do not believe it necessary to argue the status of these binomials at this point, because the matter has little immediate importance. The impor-

tant side of Wheeler's interpretation is in his statement that: "Provisional names are not only illegitimate but are not validly published. *Since they are not validly published they cannot as earlier homonyms, invalidate a later name*" (italics mine).

This statement contains an unmitigated fallacy. *Thalictrum polycarpum* is illegitimate because it duplicates *T. minus* L. (Art. 16, Art. 60[1] Amsterdam Code), and is invalid, in addition, at least because it is published as a synonym of *T. multiflorum* (Art. 40). Article 61 in the current Rules states: "Even if the earlier homonym is illegitimate, or is generally treated as a synonym on taxonomic grounds, the later homonym must be rejected." This is clear enough: *T. polycarpum* Loret is not only illegitimate and invalid but has been treated as a synonym of *T. minus* L. on taxonomic grounds by Lecoyer. Obviously, *T. polycarpum* Loret, 1859, as an earlier homonym renders illegitimate *T. polycarpum* S. Wats., 1879. The text of Article 61 and the status of the binomials both of Loret and Watson precisely and absolutely contradict Wheeler's affirmations.

Since Wheeler's error rests upon assumptions which are unfortunately widespread, it is advisable to add here a few words of comment. Many are the taxonomists who believe that a name which is not "valid" may be "ignored." This belief involves a fundamental confusion between two different concepts, which can easily be illustrated by an example. Let us suppose that John Doe publishes in 1940 *Planta una* without a Latin description. This binomial is invalid, because Article 38 of the Amsterdam Code requires a Latin diagnosis for a valid publication. Accordingly, Jack Roe can freely use the type specimen of *P. una* and propose on it in 1942 a new binomial, *P. quaevis*. Roe can do this because the publication of Doe does not "exist" as valid nomenclature on account of the lack of a Latin diagnosis. Of course, Roe, if he so wishes, can honor the earlier invalid binomial proposed by Doe, effectively publishing *P. una* with a Latin diagnosis. In this case (Art. 48), the species will be known as *P. una* J. Doe *in* (or *ex*) J. Roe.

An entirely different state of affairs obtains if J. Roe attempts to publish in 1942 a new species, naming it *P. una* and basing it upon a type specimen other than the one originally used by J. Doe in 1940 for his *P. una*. *Such a duplication is expressly forbidden by Article 61, as it has been seen.* Under the Vienna Code (1905) and Bruxelles Code (1910) it was not permitted to reject a well known name, "Because of the existence of an earlier homonym which is universally regarded as non-valid or for any other motive either contestable or of little import" (Art. 50, Vienna and Bruxelles Codes). The motives behind this Article were lofty, no doubt, but its practical application led to countless controversies and abuses, because the generality embodied in the Article was not accompanied by an elucidation of what was meant as an

homonym "universally regarded as non-valid," and what were "motives contestable or of little import." Naturally, everybody thought of his own motives as being true and relevant, and of those of his opponents as "contestable or of little import." To remedy this situation, the text now embodied by Article 61 was approved by the Cambridge Congress of 1930. Space forbids my entering into details, but I may at least point out that Miss L. Green, who is well informed on everything that was proposed and voted upon at Cambridge, states in her authoritative commentary on nomenclature (Emp. For. Jour. 10: 68. 1931) that: "*All later homonyms should be rejected even if the earlier homonym is not an accepted name*" (italics in Miss Green's text).

Much confusion reigns as to the meaning of *invalidity* as distinct from *illegitimacy* in the sense of the Rules, for the very good reason that the Rules themselves use these terms in a loose and contradictory manner. Examples of this confusion are rife in the Amsterdam Code, and one at least may be cited here. Article 2 defines as *illegitimate*, names or forms contrary to an Article, and states that such names cannot be maintained. Article 63, on its part, prescribes that the name of a taxonomic group "must be rejected when its application is uncertain". Since such a name [*nomen dubium*] "must be rejected," it stands to reason that this name is *illegitimate* under the definition given in Article 2. However, Recommendation xxxvii which immediately follows Article 63 authorizes the certification of a *nomen dubium* following an adequate taxonomic study made on the basis of new evidence (Art. 17, Rec. iii, Rec. xxxvii). Thus, Article 63 errs in stating that a *nomen dubium* "must be rejected," branding it implicitly as *illegitimate*. Such a name is merely *invalid*, proof of this being the fact that this name can be used legitimately under certification.

Since the Rules themselves are not clear as to the proper use of *validity* and *legitimacy*, it would be useless to argue here Wheeler's contention that a *nomen provisorium* is both invalid and illegitimate. Sooner or later, a fundamental debate is bound to take place in a Botanical Congress about these concepts. Meanwhile, I may contribute here a brief comment as to the meaning of *validity* and *illegitimacy*, once again using an example.

As it is well known, the law orders that a testament must conform with certain specified requirements, a part of the estate of the deceased going automatically to certain parties by reason of their being related with the author of the will. If the will is drawn *against* the law and, for instance, the estate is distributed in a manner which is forbidden by law, the will is *illegitimate*, and as such *it cannot be maintained*. A will, conversely, may be drawn *according to the law*, but before it takes effect it must go through the procedure of probating, and is not *valid* until probated. *The probating of a will is exactly the same procedure as the valid publica-*

tion of a taxonomic name. Neither a will nor a taxonomic name is *valid* until it is probated or published according to the laws of the land or the Articles of the Rules of Nomenclature. Naturally, neither a will nor a taxonomic name is *legitimate* if it violates the law of the land or the Articles. A will that violates the law and a name that violates an Article may be unimpeachable as to form, but can neither be probated nor maintained *because they are faulty as to substance*. This, in a nutshell, is the distinction that can briefly be made here between the concept of *validity* and that of *legitimacy*. It is high time that the Articles be carefully revised and amended in order that they be purged of pointless and confusing abuses of the proper terms ultimately leading to a flood of mistaken comments in the literature.

The following synonymy is in order:

THALICTRUM AMETRUM Greene in Muhlenbergia 5: 129. 1909.
T. polycarpum S. Wats. in Proc. Am. Acad. Sc. 14: 288. 1879;
 Jepson, Fl. Calif. 1: 530. 1922; Munz, Man. South. Calif. Bot.,
 173. 1935; Wheeler in Rhodora 40: 318-320. 1938. *Non*
Loret.

Arnold Arboretum, Harvard University,
 Jamaica Plain, Mass.,
 March 3, 1942.

UNA NUEVA ESPECIE DE PINUS MEXICANO

MAXIMINO MARTÍNEZ

Pinus Douglasiana sp. nov. Arbor 20 m. alta; diametros 30-50 cm.; coma densa rotundata. Cortex leviter scabris, rubescens, 2 cm. crassus, squamatus. Rami expansa; ramuli brunneo rubescentis, valde scabri. Folia 5, triangularia, crassa, rectiuscula, pungentia, 25-33 cm. longa, marginibus denso serrulato, claro virore vel galbinus coloris, fulgentia, intus glauco in folia juniora. Hypodermis biformis usque endodermis penetrabilis, chlorenquima partitus; fascies-exterius endodermis incrassatus. Ductus resiniferi 3 in parenchymatis parte siti; fascies fibrovasculares 2, approximati, patentibus. Vaginae persistentes, 20-30 mm. longae, squamatae, castanei rubescens, dein obscuro castanei. Strobilis junioribus erectis violaceo fuscus, subterminalibus, oblongis attenuatis, obtusis; squamae crassae, apex expansus vel erectus. Strobili maturi ovoidei, leviter asymmetricus, deflexi, paulum incurvati, in apex attenuati, fusco rubescens coloris, cadivus, 7.5-10.5 cm. longis, terni vel quini. Pedunculi 12 mm. incurvi ad strobili adnatus. Squamae 28-30 mm. longae, 15 mm. latae; apex irregulariter, obtuso vel rotundato; umbo subquadrangulo vel polyangulatus, carina transversa patente, carina longitudinali depressa, fere complanata in basis strobili. Cuspide complanata, paulum patente, mucro cadivo. Semina obscura fere ovoidea, 5 mm. longa, ala 25 mm. longa 8 mm. lata, brunnea. Lignum molle, album; resina fere nulla.

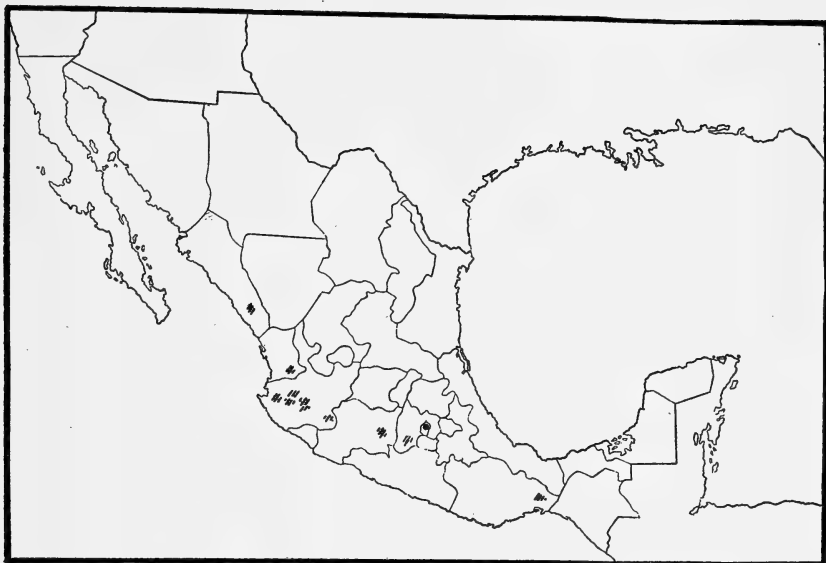


FIG. 1. Distribución del *Pinus Douglasiana*.

Typum in Instituto de Biología, Mexico; isotypi in Arnold Arboretum, Harvard University, Jamaica Plain, Massachusetts, United States National Herbarium, Washington, D. C.

He tenido a la vista ejemplares procedentes de: SINALOA. Batel, Concordia; Santa Lucía, Concordia, "pino real"; Cerro de Tecoripa, Sierra del Rosario; límites de Sonora y Chihuahua; Potrero de Bejarano, Badiraguato; Rosario. NAYARIT. Juanácata, Jala, "pinabete." JALISCO. San Martín Hidalgo; Tecolotlán; Cerca de Cuale, a 20 km. al E. de Bahía de Banderas; Ameca, "pino blanco"; Atengo, "pino blanco o pino hayarín"; Soyatlán, a 2200 m., "pino blanco"; Concepción de Buenos Aires. MICHOACAN. Tiripitío. OAXACA. El Barrio; Santiago Tlaxoyaltepec. MEXICO. Cuauhtepic, Sultepec.

Es árbol de unos 20 metros de altura, por 30 a 50 cm. de diámetro a la altura del pecho; de copa redondeada y densa; con la corteza algo áspera de 2 cm. de espesor aproximadamente, rojiza y escamosa, dividida en placas irregulares. Ramas extendidas, agrupadas en la parte superior del tronco. Ramillas morenas con tinte rojizo y muy ásperas, debido a la persistencia de la base de las brácteas, las cuales son anchas, salientes y contiguas. Se descaman fácilmente. Hojas en grupos de 5, triangulares, gruesas, casi derechas, y agudas, de 25 a 33 cm. de largo, con los bordes finamente aserrados, de color verde claro, algo amarillento, brillantes, con tinte glauco en las caras interiores, solamente visible en las hojas tiernas. El hipodermo es biforme, muy grueso con 5 capas de células desiguales e irregularmente colocadas, y presenta entrantes, a veces dobles, que llegan al endodermo seccionando el

clorénquima; las paredes exteriores de las células endodérmicas son muy engrosadas. Tienen dos fascies vasculares contiguos, bien distintos, rodeados arriba y abajo de células de refuerzo; los canales resiníferos son medios y en número de tres. Las vainas son persistentes, de 20 a 30 mm., escamosas abajo y aniladas arriba, de color castaño rojizo al principio y castaño obscuro después. Las yemas son cónicas, de color naranjado rojizo. Los conillos son moreno violáceos, erguidos, oblongos, subterminales, algo atenuados en ambas extremidades, romos, generalmente en grupos de tres, con escamas gruesas, armadas de puntas extendidas o dirigidas hacia el ápice. Conos largamente ovoides, algo asimétricos, reflejados, ligeramente encorvados, atenuados hacia el ápice, de color moreno rojizo, opacos, caedizos, de 7.5 a 10.5 cm. Se presentan en grupos de 3 a 5, sobre pedúnculos de unos 12 mm., siempre encorvados, quedando con el cono cuando éste cae. Escamas de unos 20 a 30 mm. de largo, por 15 de ancho, de ápice irregular, obtuso o redondeado, umbo irregularmente cuadrangular o poligonal, rugoso, quilla transversal patente y una saliente perpendicular poco marcada; apófisis irregular, subpiramidal, algo levantada (casi aplanada en las escamas basales), cúspide aplanada o muy poco saliente, con espina pronto caediza. Semilla oscura, casi ovoide, de unos 5 mm., con ala de 25 mm. de largo por unos 8 de ancho, de color moreno. La madera es blanda, de color blanco; con muy escasa trementina. Se emplea en construcciones y para muebles.

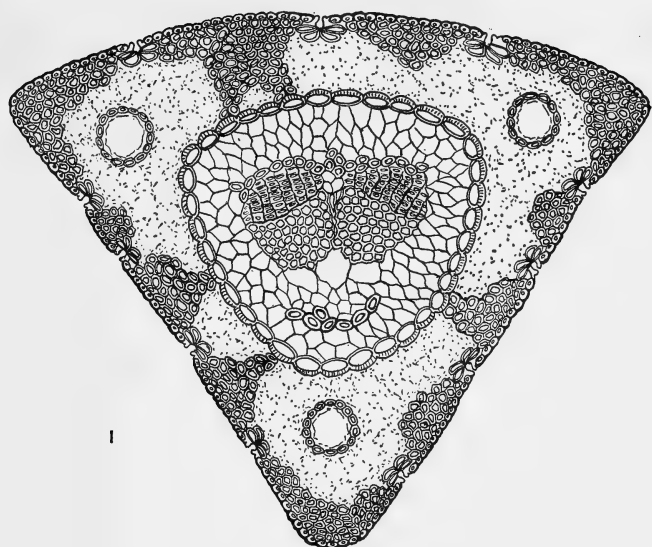
Este pino, quizá incluido por Shaw en el *Pinus pseudostrobus* var. *tenuifolia* (Benth.) Shaw, coincide con éste en la estructura de las hojas, pues el hipodermo forma entrantes, a veces dobles, que llegan al endodermo, pero dichas hojas son gruesas y fuertes, de 25 a 33 cm., tiesas y derechas, en tanto que las del *Pinus tenuifolia* son muy delgadas, flexibles y colgantes. Los conos en lo general coinciden con los del *P. tenuifolia*, pero las apófisis son más gruesas.

Teniendo en cuenta que las hojas no son delgadas, sino por el contrario, gruesas y fuertes, no puede convenirle la denominación de *tenuifolia*, ya que la característica de éste, como claramente lo indica el nombre, es que las hojas son delgadas. El árbol se encuentra en una zona relativamente amplia (desde Sinaloa a Oaxaca).

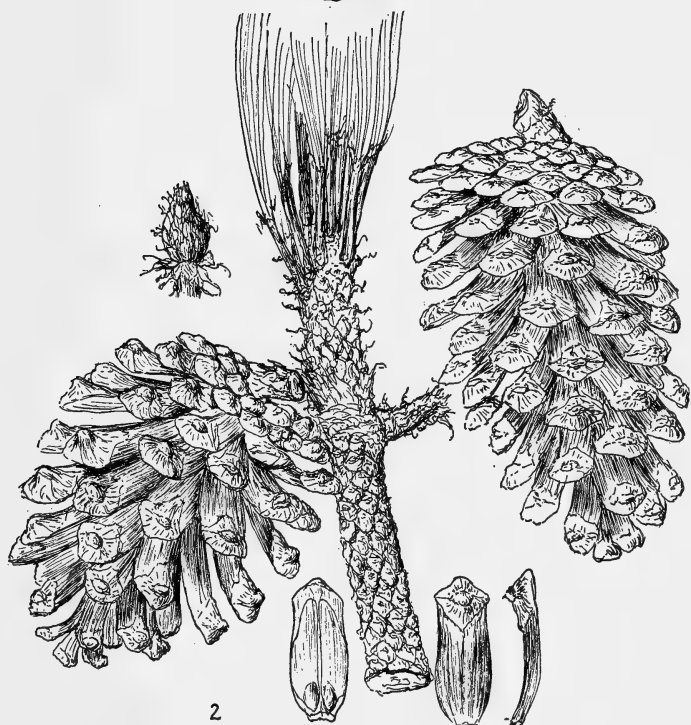
Por tales razones he visto la conveniencia de considerarlo a parte con rango específico.

Su zona de vegetación, como se ve, comprende Sinaloa, Nayarit, Jalisco, Michoacán, México y Oaxaca (probablemente también Guerrero), formando masas puras. Se le ve asociado con *Pinus Lumholtzii*, *Pinus leiophylla* y *Pinus oocarpa*.

Se denominó en honor de la Señora Margaret Douglas, dama norteamericana, entusiasta admiradora de la Flora Mexicana, y protectora de los estudios de la misma.



1



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PLATE 1. *PINUS DOUGLASIANA*. Fig. 1. Sección transversal de la hoja.
Fig. 2. Rama y conos. (Dib. de M. Ornelas C.)

SUMMARY

Pinus Douglasiana was perhaps included by Shaw under *P. pseudostrobus* var. *tenuifolia* (Benth.) Shaw, but it differs from this in its longer, stouter, leaves and larger apophyses of the cone scale. It occurs from Sinaloa to Oaxaca. It is named in honor of Mrs. Margaret Douglas.

Morelia 61, México, D. F.
Mayo de 1942.

AN INVESTIGATION OF THE PRESENCE OF SILICEOUS
RODS IN THE SECONDARY WALL OF
WOODY TISSUE¹

WALTER M. SCHALL

In 1920, Forrest B. H. Brown (3) proposed an explanation of differential wood shrinkage by stating that a skeleton of siliceous rods existed within the secondary wall of wood elements. He assumed that these rods, acting as a restraining framework, kept longitudinal shrinkage at a minimum. Since the presentation of this explanation, many workers in cell wall structure (6, 7, 12) have referred to this siliceous skeleton or have tacitly assumed its presence, notwithstanding the fact that the micelle theory advanced by Nägeli (13) in 1863 and substantiated by subsequent workers (1, 2, 7, 11, 12, 17) is now generally accepted as the logical explanation for the shrinkage behavior of wood. The present study was undertaken not to explain the mechanics of shrinkage but rather to investigate the procedure employed by Brown (3), first to check his results and second, if similar results could be obtained, to interpret them in the light of the accepted theories regarding wood shrinkage.

The author wishes to give acknowledgment and thanks to Dr. R. A. Cockrell for his interest and suggestions, both in conducting the investigation and writing the final manuscript.

In repeating Brown's (3) work, the following species of wood were used: *Swietenia mahagoni*, *Trochodendron aralioides*, *Quercus alba*, *Cedrela* sp., *Pinus strobus*, and a lapachol-forming species of *Tecoma*. *Tecoma*, according to Record (15, p. 532), is divided into four groups, "Prima vera," "roble," "ipé peroba," and "lapacho" or "páo d'arco." The "lapacho" group is characterized by having wood that is very "hard and heavy, has an oily olive-brown color, and the vessels are more or less completely filled with yellow crystalline substance (lapachol), which may give the surface the appearance of having been dusted over with sulfur. Ripple marks are always present and usually regular." Lapachol ($C_{15}H_{14}O_3$) "when moistened with ammonia or dilute

¹Contribution of the Department of Forestry, University of California, Berkeley.

sodium carbonate, turns a deep wine-red, thus providing a reliable diagnostic feature." In order to give comparable results with Brown (3), the results of tests made on *Tecoma* sp. are completely reported although the same tests with comparable results were made on the other material.

If a siliceous skeleton were present in the secondary wall of woody tissue, a change in dimension might take place upon desilicification. To test this, following Brown's (3) procedure, blocks of the foregoing species were placed in hydrofluoric acid to dissolve silica thereby eliminating its reputed restraining effect on shrinkage. In addition, duplicate control blocks were placed in hydrochloric acid which does not dissolve silica but which in other respects should have an effect on the cell wall substance similar to that of hydrofluoric acid. The blocks, ranging in size from one-half to one inch in linear dimension, with true radial, tangential, and longitudinal faces, were measured with a micrometer and placed in boiling water. After five and one-half hours of boiling, during which the blocks were measured at one-half hour intervals, duplicate blocks of each species were immersed in separate solutions of concentrated hydrochloric and 52 per cent hydrofluoric acid. Measurements of the change in dimension were made after eighteen, twenty-three, twenty-eight and thirty-one hours' immersion. After washing in running water for ten hours, and measuring again, the blocks were placed in an oven at 103° C. to remove the excess moisture. The moist blocks were then allowed to air-dry for eight days. Since the swelling values for each of the species followed the same general trend, only the values for *Tecoma* sp. are included. These are recorded in Table I.

In order to supplement the block measurements, individual fibers obtained by maceration with concentrated nitric acid and potassium chlorate (4) were treated with both hydrofluoric and hydrochloric acid. The fibers were mounted in alcohol and measured both in length and width under the microscope. The alcohol was then allowed to evaporate and the acid was added. In no case did the fiber length change after contact with either acid for an hour. If silica in the form of rods was present, the time in hydrofluoric acid was sufficient to dissolve the silica from the fiber. Since no measurable change was observed, it must be concluded that the acids did not remove the restraining force holding the fiber cell wall together, and the cell wall must have been fully swollen before the acids were added.

The effect of chemical treatment on the physical characteristics of the wood was marked. In several cases the blocks showed a decided tendency to check and some even showed some collapse. These same blocks were brittle and a slight pressure on any of the faces caused splitting that took place tangentially along the annual rings as well as radially along the rays. It is not likely that merely drying the wood would cause such extreme stresses to

TABLE I
Percentage Swelling for *Tecoma* sp. in Water and Acid*

	Time	Tangential		Radial		Longitudinal	
Per cent change in boiling water	½ hour	5.4	7.0†	3.6	6.0†	0.8	0.1†
	1 hour	6.0	11.0†	3.9	10.0†	0.8	0.1†
	1½ hours	6.3	12.7†	3.9	11.0†	0.8	0.1†
	2½ hours	6.7	12.7†	4.2	11.0†	0.8	0.1†
	3½ hours	7.0		4.2		1.1	
	4½ hours	7.0	13.0†	4.2	11.0†	1.1	0.1†
	5½ hours	7.1		4.2		1.1	
Per cent change in concentrated hydrochloric acid at room temperature	18½ hours		12.2		7.3		0.3
	23 hours		12.8		7.6		0.3
	28 hours		12.8		7.5		0.3
	31 hours		12.8		7.3		0.3
Per cent change at air dry moisture content	8 days		-4.7		-4.3		0.1
Per cent change in 52 per cent hydrofluoric acid at room temperature	16 hours	8.2	15.0†	4.4	11.0†	0.5	0.1†
	20½ hours	7.7	85.0†	4.6	43.0†	0.5	-18.0†
	27½ hours	7.5	57.0†	4.4	29.0†	0.3	-22.0†
	30½ hours	7.5		4.3		0.4	
Per cent change at air dry moisture content	8 days	0.1	-13.8†	2.2	-19.0†	0.0	-40.0†

* Values represent averages for at least four determinations. Negative values represent shrinkage.

† Results as obtained by Brown (3) for similar treatment.

be set up but it is probable that the splitting action was caused by a material weakening of the cell wall by chemical action. These checked blocks were disregarded and only apparently sound blocks were used for measurement.

In determining the air-dry moisture content before and after acid treatment, it was found that the hygroscopicity had decreased. After treatment with hydrochloric acid, the moisture content of the blocks was reduced to three-fourths of the original value and after treatment with hydrofluoric acid to one-third. Again, this would indicate that the acids caused a chemical and physical change in the minute structure of the cell wall so that its original equilibrium moisture content was significantly reduced.

Each of the untreated blocks was sectioned on a microtome, using a jet of a steam to soften the woody tissue. The sections, mounted in water, were examined at 1300 diameters under a Zeiss binocular microscope equipped with an oil immersion apochromatic objective (N.A. 1.3) and 10× compensating eyepieces. Likewise, sections mounted in glycerine were examined and even after contact with the liquid for twelve hours, in no case was there any indication that small isolated areas, supposedly the cut ends

of siliceous rods, were present. The photomicrograph of a cross section of *Tecoma* sp. (fig. 1) taken at 810 diameters shows no discontinuities in the cell wall.

The index of refraction of the cell wall, as found by Brown (3), was verified using McLean's Solution (4) of known indices on cross sections of *Tecoma* sp. Since the index of refraction of the secondary wall and silica are practically the same, the proximity of the two indices may have obscured any possible difference due to the presence of silica.

Both the cross sections and the individual fibers of *Tecoma* sp. were incinerated to see if visual evidence of the rods could be found during the course of incineration or in the ash. Individual cells were

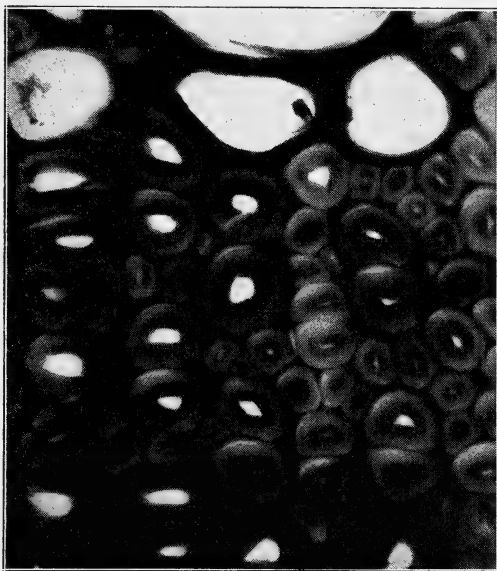


FIG. 1. Transverse section of a lapachol-forming species of *Tecoma*. $\times 810$.

isolated from a section 14 microns thick and incinerated over an alcohol flame. The heating time was lengthened for successive sections so that examination could be made at varying degrees of incineration. Under the microscope, the ash showed irregularities but no regular arrangement of bodies was noted. According to Uber (19), these irregularities are probably a result of a natural tendency of the ash to check upon shrinkage. Macerated fibers were incinerated the same way but again no visual evidence of the localization of silica was obtained.

In addition to determining the effect of the presence of a siliceous skeleton on the shrinking and swelling of wood, the actual amount of silica present was determined. Following Brown's (3) procedure, this determination was carried out in two steps. The first was to determine the ash content and the second to determine the per cent silica in the ash. An oven-dry sample of *Tecoma* sp. was accurately weighed and ashed in an electric muffle at moderate red heat. The weight of ash thus obtained was 0.25 per cent of the dry weight of wood. A silica determination based on the weight of ash was made using hydrochloric and perchloric acid in the quantitative analysis (9). The weight of

silica thus obtained gave an average of 0.85 per cent of the dry weight of ash.

The values obtained for ash and silica content are considerably below those given by Brown (3). He states that, "after combustion, 1.8 per cent (of the dry weight of the fiber) of mineral matter was obtained and 0.1 per cent (of the dry weight of the fiber) of silica or silicic acid." These percentages are of little value since they are based on the dry weight of fiber which can be obtained only arbitrarily. The maceration procedure is extremely variable since neither the time nor the temperature of reaction is standardized. A trial maceration using concentrated nitric acid and potassium chlorate (15), gave a dry weight of fibers for *Tecoma* sp. equal to 42 per cent of the dry weight of wood. Based on the dry weight of fibers, this would give values for ash and silica content approximately twice as large as results based on the dry weight of wood if the assumption was made that all the mineral matter was retained by the macerated material. A comparison of ash and silica content cannot be made with any marked degree of accuracy, however, since within a single tree, the values vary from periphery to pith and from the base to the top of the tree.

It is not outside the realm of possibility that inorganic materials are centralized within certain areas in the cell wall. Kerr and Bailey (11, p. 285) state that "the central layer of normal tracheids, fiber-tracheids, and libriform fibers is composed, in all cases, of a complex and firmly coherent matrix of cellulose with elongated, intercommunicating interstices. Within these interstices more or less 'lignin' and other non-cellulosic constituents may be deposited." Bailey (1) recently states specifically that minerals may be deposited within these interstices. Since the mineral content occupies such a small percentage of the weight of materials within the interstices, it is improbable that silica would be so localized as to form a continuous rod.

In view of these findings, it is not likely that a highly silicified skeleton is present in the secondary wall of woody tissue. The results of swelling tests alone should be conclusive evidence of this fact since several species of wood were used and the blocks treated with two mineral acids, one of which would dissolve silica while each should have similar effects on the cell wall structure. If siliceous rods were present they would certainly have been disintegrated after immersion in 52 per cent hydrofluoric acid for 30 hours. As indicated in Table I, a small increase in size was observed but no appreciable difference was noted between the blocks placed in hydrofluoric acid and those placed in hydrochloric acid. Furthermore, the individual fibers failed to give a measurable change when each of the acids was added. In a schematic drawing of a fiber before and after hydrofluoric acid treatment, Brown (3) indicates that the diameter increases and the length decreases with the acid treatment. He explains the

change by stating that the siliceous rods had been broken, thus freeing the so-called homogeneous substance which could then swell without hindrance. If the cell wall is a homogeneous substance, the fiber should have increased in length and width in the same proportion and an inverse relationship could not have resulted.

The acids probably caused a degradation of both lignin and cellulose as well as attacking any of the minerals in the wood. This is borne out by the mechanical weakening of the wood and by the reduced hygroscopicity. Chamberlain (5) and Sacc (17) state that the action of hydrofluoric acid is to soften wood but they do not point out the manner of softening. Plowman (14) in 1904 stated that the action of hydrofluoric acid was to remove silica and other mineral deposits from the wood. Kerr (10) and Harlow (8) point out that the action of hydrofluoric acid is to attack the cell wall substance and the removal of silica is a secondary operation. Harlow (8) explains the softening action as a degradation of lignin since the treated wood does not respond to the Maulé reaction which is employed as a test for the presence of lignin. Kerr (10), on the other hand, states that the action is due to a degradation of cellulose to hydrocellulose and explains the action by drying other acids into wood in order to soften the woody tissue. Rudiger (16) points out that swelling precedes the dissolution of cellulose in liquid hydrofluoric acid and that the lignin structure of the membranes was destroyed, although the lignin itself did not swell. Forsaith (6) in his explanation of differential swelling of wood with adsorption of water credits the siliceous skeleton as proposed by Brown (3) as exerting an influence in conjunction with the micelle theory as proposed by Nägeli (13). A more recent worker, Maby (12, p. 434), in his explanation of shrinkage and swelling, says, "On the other hand, the longitudinal siliceous strands in the cell wall, noted and described by F. Brown, might be expected to exert a binding effect over dimensional changes in the longitudinal direction."

Schorger (18, p. 9) states, "Nägeli, as a result of his study of the growth of starch grains and the cell wall, concluded that the cell wall consists of ultramicroscopic, crystalline, molecular complexes which he called micellae. By this assumption he was able to explain striation, stratification, swelling, double refraction, and other properties of the cell wall." Subsequent workers have followed this general idea. Bailey (1, 2) points out that the cellulose consists of chains of anhydrous glucose residues which tend to aggregate in a parallel fashion. He also states that the aggregation of chain molecules is not in separate groups but rather a part of a continuous system which is held together by overlapping chain molecules and perforated by intercommunicating spaces. It is probably in these intercommunicating spaces that water is adsorbed and causes the changes in the dimension of wood. The mineral content is also probably localized here but

evidence of a continuous bond between inorganic material of the cell wall has not been found.

CONCLUSIONS

1. Silica in the form of continuous siliceous skeletons is not present in the secondary wall of woody tissue.

2. The silica content is such a small percentage of the total weight of wood that it could not have an appreciable effect, greater than other minerals, on the differential swelling or shrinking of wood.

3. Other than bringing about more rapid degradation of the wood substance, hydrofluoric acid is similar to hydrochloric acid in its action on the cell wall.

University of California, Berkeley,
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A NEW CLIFF-ROSE FROM ARIZONA

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It was noted in a recent publication¹ that an apparently undescribed *Cowania* occurs in western Arizona. The writer is now convinced that this plant merits recognition as a species.

Cowania subintegra sp. nov. Frutex parvus, ramulis ascendentibus-patentibus 30-75 cm. longis, cortice albo-griseo; folia nec viscida nec distincte glanduloso-punctata, integra vel nonnunquam apicem versus 1-2-dentata, usque ad 15 mm. longa et 3 mm. lata, spathulata, apice obtusa, basi attenuata, margine valde revoluta, supra laetevirentia et parce araneosa, subtus dense albo-lanata; ramuli, pedicelli, hypanthium, et calycis lobae tomentosi sine glandulis stipitatis; pedicelli 4-11 mm. longi hypanthium subaequantes vel valde superantes; hypanthium infundibuliforme 5-7 mm. longum; petala ochroleuca.

A straggling shrub with stems up to 75 cm. long, the branches ascending-spreading, the bark pale gray, becoming somewhat shreddy; herbage not viscid; twigs, pedicels, hypanthium tube, and outer face of the calyx lobes whitish tomentose, without stipitate glands; leaves up to 15 mm. long and 3 mm. wide but usually shorter and narrower, mostly 1-veined and entire but occasionally with 1 or 2 subapical rounded teeth, oblanceolate, obtuse at apex, attenuate at base, the margin strongly revolute, thick, minutely and obscurely glandular-punctate, bright green and loosely arachnoid-pubescent over the whole upper surface, the lower surface densely and conspicuously white-lanate; pedicels 4 to 11 mm. long, nearly equaling to much longer than the hypanthium; hypanthium narrowly funnellform, attenuate at base, 5 to 7 mm. long, in anthesis about 3 mm. wide at summit; calyx lobes about 4 mm. long, broadly ovate, rounded at apex and sometimes obscurely apiculate, denticulate-ciliolate, spreading at anthesis, becoming reflexed; petals ochroleucous, about 10 mm. long and 6 mm. in greatest width, rounded and slightly erose (occasionally shallowly cleft) at apex, cuneate at base; stamens about 40, the filaments about 4 mm. long, the anthers 1.25 mm. long, nearly orbicular; pistils 3 to 7, the ovary short-stipitate, densely sericeous, the style 6 to 7 mm. long at anthesis, sericeous on the lower one-half to two-thirds, naked above; achenes about 6 mm. long, narrowly obpyramidal, glabrous except near the apex, the persistent style about 25 mm. long (perhaps longer at full maturity), silky-plumose with long antrorse hairs except the apical portion, this naked, 2 to 3 mm. long.

The type was collected about two miles west of Burro Creek crossing on the road from Wikieup to Hillside, southeastern Mohave County, Arizona, near the Yavapai County line, altitude

¹ Kearney, Thomas H., Peebles, Robert H., and collaborators. Flowering plants and ferns of Arizona. United States Department Agriculture Misc. Publ. 423: 405. 1942.

2,500 feet, April 18, 1941 (*Darrow & Benson 10891*). The species is known only from the type locality, where it had been collected first on April 20, 1938 (*Darrow & Crooks 3*). On both dates of collection, only a few late flowers persisted, but the fruit was not yet fully mature. Dr. Lyman Benson stated (personal communication): "The base of the plant is perhaps as much as one to one and one-half inches thick, but the trunk continues for only a few inches above ground." He also reported: "We found the plant growing in a rather limited area on disintegrated material of a peculiar white rock and associated with a vegetation entirely different from that on surrounding territory. However, although the distribution of the plant was restricted, it was locally abundant."

Cowania subintegra strikingly resembles *C. ericaefolia* Torr. of western Texas in habit, appearance, small stature, and very narrow, mostly entire leaves, but the Texas species has linear, sharply cuspidate leaves not more than 6 millimeters long, stipitate glands on the hypanthium (often also on the pedicels), and darker colored bark.

The flowers and fruit of *C. subintegra* apparently present no characters that are not within the range of variation of *C. Stansburiana* Torr., but that is a much larger and more erect shrub, attaining (exceptionally) a height of seven and one-half meters. The branchlets are more stiffly ascending, the bark reddish brown or dark gray, and the herbage usually very viscid. The leaves are much larger, cuneate-obovate in outline, pinnately veined and deeply 3-cleft with the terminal lobe in turn 3-toothed or 3-cleft, and they are nearly always conspicuously punctate with few large glands. With the single exception, so far as the writer knows, of the specimen noted in the next paragraph, the pedicels and hypanthium are beset with stipitate glands and are not tomentose, or but thinly so.

A collection from near Rye Creek, Gila County, Arizona (*Collom 97* in 1933), has the herbage non-viscid, the leaves minutely and inconspicuously punctate, and the pedicels and hypanthium densely pubescent and lacking stipitate glands. In these characters it resembles *C. subintegra* but in other respects it is not distinguishable from *C. Stansburiana*.

The writer believes that Jepson was justified in reducing *C. Stansburiana* to a variety of *C. mexicana* D. Don (*Man. Fl. Pl. Calif.* 498. 1925). The diagnostic characters given by Rydberg in his key and descriptions (*N. Am. Fl.* 22: 415, 416. 1913) are as follows:

C. mexicana: Hypanthium campanulate, abruptly contracted into the pedicel. Glands of the pedicel sessile and often hidden in the tomentum.

C. Stansburiana: Hypanthium funnellform, gradually contracted into the pedicel. Glands of the pedicel stalked.

Standley (*Contrib. U. S. Nat. Herb.* 23: 326. 1922) mentions also that the leaf lobes are entire in *C. mexicana*, whereas at least

the terminal lobe is cleft or dentate in *C. Stansburiana*, as was pointed out by Torrey in his original description (in Stansb. Expl. Great Salt Lake, 386. 1852). The color character of the bark given by Standley does not hold, many specimens of *C. Stansburiana* from Utah and northern Arizona having brown bark.

The manner in which the several characters are associated in specimens from Mexico and from the United States is shown in Table 1. It is evident that whereas in most of the specimens the

TABLE 1. Association of characters in specimens of *Cowania* in the United States National Herbarium that have been referred, respectively, to *C. mexicana* and *C. Stansburiana*.

Species and collection	Primary leaf lobes		Hypanthium		Stipitate glands on hypanthium, etc.	
	Entire	Toothed or cleft	Campanulate, ± abruptly contracted at base	Funnel-form, attenuate at base	Present	Absent
<i>C. mexicana</i>						
Rose 11659, Cusi-huiriachie, Chih. . .	X		X			X
E. Palmer 12, Tepehuanes, Dur.	X			X		X
E. Palmer 71, Papasquiario, Dur.	X		X			X
E. Palmer 4669, Papasquiario, Dur.	X		X			X
Dugès in 1899, mountains, Guanajuato .	X		—	—	—	—
<i>C. Stansburiana</i>						
Most specimens from Utah, Arizona, etc..		X		X	X	
Hartman 276, Naçori, Son.		X		X	X	
M. E. Jones 5586c, Provo, Utah		X	X		X	
V. Bailey 1457, near St. John's, Ariz. . .		X	X		X	
Knowlton 238, Grand Canyon, Ariz.		X	X		X	
Collom 97, Rye Creek, Ariz.		X		X		X

characters considered by Rydberg and by Standley to be diagnostic of *C. mexicana* and *C. Stansburiana*, respectively, tend to be associated as indicated by them, there are several marked exceptions. Thus two of the five specimens referred to *C. mexicana* have the hypanthium funnelform or intermediate,² rather than

² D. Don, in his description of the genus *Cowania*, based solely upon *C. mexicana* (Trans. Linn. Soc. London 14: 575. 1825), states: "calyx [hypanthium] obturbatus basi attenuata tubulosus." His illustration (Tab. XXII), however, shows the hypanthium as campanulate and abruptly contracted.

campanulate, and three specimens from Utah and Arizona that are *C. Stansburiana* in all other characters have a campanulate hypanthium that is abruptly contracted at base. One of the Mexican specimens (*Dugès* in 1899) that has the entire primary leaf lobes of *C. mexicana*, is intermediate in shape of the hypanthium and the latter is conspicuously glandular, although the glands are sessile or nearly so. The specimen from Rye Creek, Arizona, as was noted in a preceding paragraph, although conforming to the characterization of *C. Stansburiana* in shape of the leaves and of the hypanthium, lacks the stipitate glands. It is also aberrant in having the leaves obscurely and minutely punctate, not conspicuously and coarsely so, as in all other specimens of *C. Stansburiana* and in all specimens of *C. mexicana* examined by the writer.

Bureau of Plant Industry,
United States Department of Agriculture,
Washington, D. C.
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FRANCESCO FRANCESCHI

JOHN M. TUCKER

This paper is a brief account of the life and work of the man who stands out above all others in the history of horticulture in southern California—Dr. Emanuele Orazio Fenzi, known to his associates in this country in later life as Dr. Francesco Franceschi. In gathering data I drew upon a number of sources, and take this opportunity to express my appreciation to the following persons for the assistance they have given me: to Dr. Emily O. Lamb, who lived with the Fenzis at Santa Barbara as a member of the family for fourteen years, to Mr. Peter Riedel and to Mr. H. M. Butterfield, for much of the information contained in the following pages; to Mr. Butterfield, Miss Annetta Carter, and Mr. M. Van Rensselaer, for the loan of horticultural catalogues and journals—sources of much valuable data; to Dr. H. L. Mason, for placing at my disposal a collection of Franceschi's business correspondence (a fund of information of which I have scarcely scratched the surface), and to Dr. Howard S. Reed, for guiding my efforts in preparing this paper. Particularly informative also, were the following two articles: "Una gloria dell'orticoltura italiana. Il Dott. Emanuele Orazio Fenzi," by Mario Calvino—(*L'Agricoltura Coloniale*, 22: 122–128. 1928.) and "Dr. Fenzi's Contributions to American Horticulture," by F. W. Popenoe (*Journ. Hered.* 13: 215–220. 1922.).

Emanuele Orazio Fenzi was born March 12, 1843, in Florence, Italy. His grandfather was a very wealthy banker of that city and a senator, a man of an aggressive dominating personality. The Fenzi family were patrons of the arts and sciences, and followed the latest developments in these fields with great interest.

The renowned pianist, Anton Rubinstein, was a friend of the family, and on his visits to Florence, used to come to their home to practice, because their piano was the finest in the city. Thus, the background of young Fenzi was one of culture and wealth, with its attendant advantages.

In early youth he lost his parents, and his grandfather took it upon himself to see that he was properly educated. The grandfather, seeing his young charge as a future man of affairs, sent him to the University of Pisa to study law. Although he would far rather have studied botany, he complied with his grandfather's wishes and in 1864 received the degree of Doctor of Laws.

After leaving the university, he turned to botanical and horticultural pursuits, despite the fact that his grandfather wanted him to start upon a business career. Endowed with a large estate which made him financially independent, he was able to indulge his tastes as he chose in the years that followed. At his country place near Florence, he formed an arboretum of rare trees, and on the estate of a relative near Rome, he assembled a large collection of plants from countries all over the world. He was the first to introduce bamboos to Italy; *Genista monosperma* was another of his introductions. He did considerable work in the improvement of grape and olive culture in Italy, and frequently contributed horticultural and botanical articles, not only to Italian periodicals, but to the English journal, "The Gardener's Chronicle," as well. Fenzi travelled a great deal, and at one time or another visited all the principal botanical gardens of Europe. In May, 1874, he served as secretary of the International Agricultural Exposition at Florence and edited its catalogue. Shortly thereafter, he became the first secretary of the Royal Tuscan Society of Horticulture, an organization of which he was later president.

His activities in later years were not confined to the fields of horticulture and agriculture, however. When his grandfather died, he took charge of the affairs of the bank and, in addition, managed an estate. He was instrumental in establishing an electric tram line to Fiesole, the first in Italy, and the steam lines at San Casciano and Greve. But he had so little enthusiasm for business, that he soon turned over the management of the bank to a cousin. Then, during the economic crisis of 1889-90 Fenzi was forced to close the bank. In order to settle accounts with its creditors he found it necessary to liquidate virtually everything he owned, so that, finally, he and his family were left with only a very small fraction of their once large fortune.

Because of his losses, he was no longer hampered by a multitude of business matters, and saw a chance to put his interest in plants to work. His ambition was to gather together in one area plants from countries all around the globe. He decided to go to southern California because the climate was well suited to his purpose. So, in 1893, he came to Los Angeles, his wife and fam-

ily remaining in Italy. He was in California six years before they joined him. From a strong feeling of family pride he dropped the surname, Fenzi, lest the stigma of his bank failure follow him to America, and adopted in its place a family name, Franceschi. During the twenty years he spent in California, he was known to all but his intimates, as Dr. Francesco Franceschi. In Los Angeles, he met J. C. Harvey, the elder Mr. Howard, E. D. Sturtevant, and other horticulturists and nurserymen. He remained there only a year, however, before he moved to Santa Barbara where he entered into partnership with C. F. Eaton in raising nursery stock. After a short time, the partnership was dissolved and Franceschi started a nursery business of his own, calling his organization the Southern California Acclimatizing Association.

To obtain new species he wrote to botanical gardens, collectors, and plantmen in all parts of the world, and soon developed an extensive correspondence. Here the unusual linguistic ability Franceschi possessed stood him in good stead, for he read, wrote and spoke not only his native Italian, but also English, German, French, Spanish, and modern and ancient Hebrew.

Yet his interest was far from being confined to exotics. He was ever on the lookout for any elements of the native flora that might possess striking ornamental qualities. Indeed, in November, 1894, having been in Santa Barbara less than a year, he made a week's trip to Santa Cruz Island, the largest of the Santa Barbara Channel Islands. While there he obtained seeds of several different species which were at that time unknown in the horticultural trade. The most noteworthy of these was *Lyonothamnus floribundus* var. *asplenifolius*, the Santa Cruz Island ironwood. Unable to find any seedlings of this tree, he laboriously dug up a living stump and gathered some seed. With considerable difficulty, he managed to carry his prize back to camp, and on his return to the mainland planted it in his lathhouse in Montecito, a few miles from Santa Barbara. In five or six months it had started to sprout. The next year, when he moved his nursery to Santa Barbara, he transplanted it to his new location where, in a few years, it developed into a fine tree. From the seed, Franceschi obtained several trees, one of which is the fine specimen to be seen today in the grounds of the old botanical garden north of the library, on the campus of the University of California at Berkeley.

He had been in Santa Barbara only a year, when, in 1895, he published a small book entitled, "Santa Barbara Exotic Flora." This book contains a good deal of meteorological and climatic data, and observations on the soil and native flora of the region. It includes notes on the history of plant introduction in the region, and mentions the two oldest introduced trees of the town, *Casimiroa edulis*, the White Sapote, and *Prunus Capuli*, the Capulin Cherry, both natives of Mexico. This volume gives an apparently comprehensive review of the exotic plants then cultivated in

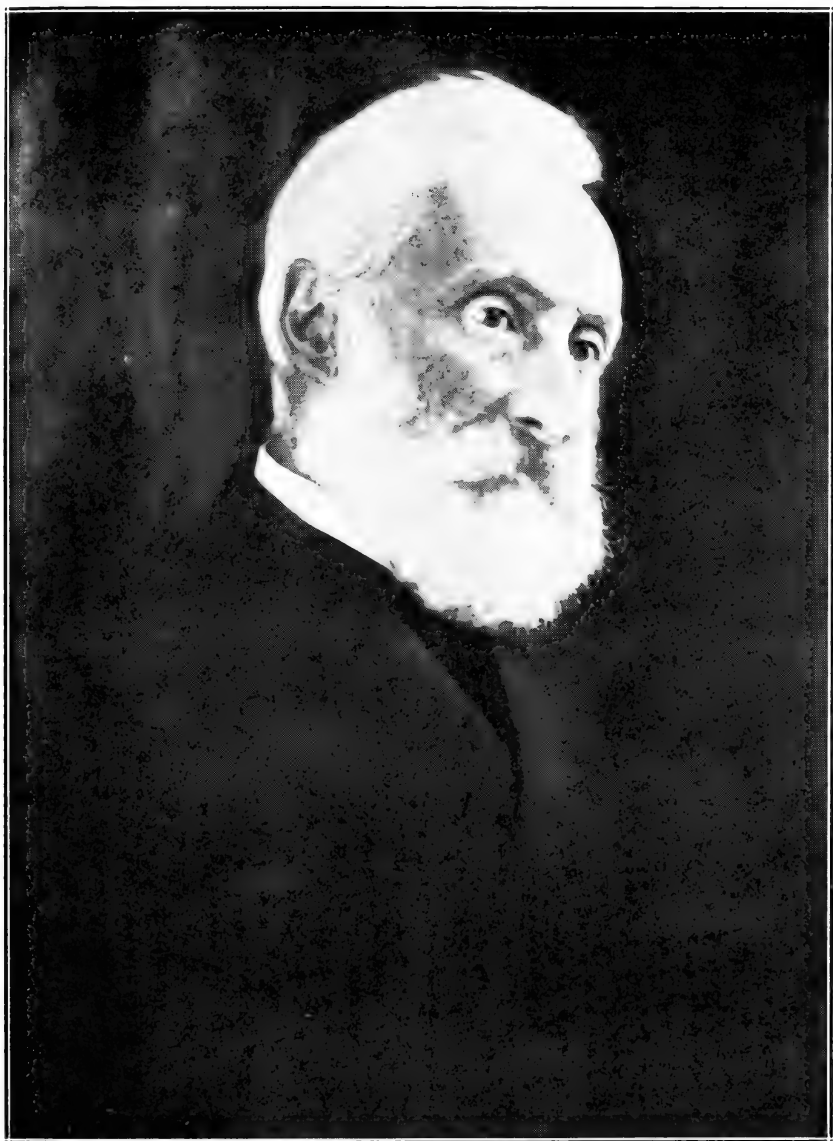


PLATE 2. FRANCESCO FRANCESCHI.

Santa Barbara and evidences the keenness of Franceschi's observations, and the breadth of his botanical knowledge.

David Fairchild, in his recent book, "The World Was My Garden," tells of meeting Franceschi at Santa Barbara in 1898. He speaks of Franceschi's enthusiasm in the following words: "Santa Barbara in 1898 was but a simple, small town. Residents of the beautiful hillside villas today would not credit their eyes could they visualize the bare, sparsely settled roads where I drove with Dr. Franceschi. . . . Santa Barbara was so undeveloped that I considered him visionary and over-optimistic. However, he foresaw the future more clearly than I, and lived to see Santa Barbara become a great winter resort containing hundreds of beautiful villas like those on the Riviera." Fairchild, at that time with the United States Bureau of Plant Industry, was impressed with the work Franceschi was doing, and had numerous new plant introductions of the Bureau sent to him from time to time for trial in Santa Barbara.

In 1904 Franceschi acquired forty acres of land on Mission Ridge, at that time a dry, barren hillside entirely outside the bounds of the city. Here he built the house in which he lived until he left Santa Barbara, a place he named "Montarioso." He established another nursery here, and, in order to have an ample water supply, built a small reservoir near the top of the hill. A perusal of his business correspondence leaves one with the impression that he was not blessed with much financial success during the following years. In June, 1904, his propagating house burned and he appears to have been considerably in debt in the months that followed. In 1907 he went into partnership with Mr. Peter Riedel, and incorporated the Southern California Acclimatizing Association, hoping thereby to be relieved of some of the burden of routine business matters. This arrangement did not work out well, however, and after little more than a year, in 1909, they decided to dissolve their partnership. Following this incident, Franceschi continued his business independently on Mission Ridge, calling it the Montarioso Nursery. By offering his services in landscaping and maintenance of the grounds of a number of estates in Montecito, he was able to bolster his income. However, the continued cost of introducing new plants, a work Franceschi carried on despite his reverses, and the limited demand for his exotic rarities, made financial disaster inevitable.

It is not surprising, therefore, that upon receiving an offer from the Italian government in 1912, to take a post in the African colony of Libya, he decided to accept. He was to introduce new plants having agricultural and horticultural value, and to do what he could to develop agriculture in the colony, the government furnishing the land and facilities for his introduction grounds. Accordingly, on July 21, 1913, he bade farewell to Santa Barbara, and with his wife and daughters, started out for his native Italy.

His two sons remained in California, the older carrying on the business as manager of the Montarioso Nursery. For the next year and a half, Franceschi lived in seclusion on the Italian Riviera, preparing the manuscript of a book, "Frutti Tropicali e Semi-Tropicali," which was published at Florence in 1915. A short time later, he made a reconnaissance trip to Libya, accompanied by his nephew, Guido Corsini, and in February, 1915, laid out his establishment in the city of Tripoli. Thus, at an age when most men would have been long since retired, Franceschi, at 72, was setting out on a fresh venture. He held this post for several years, and then retired to carry on the same work at his own expense.

In 1922, he was awarded the third Meyer Memorial Medal by the council of the American Genetic Association. This is a medal presented periodically to persons who have accomplished outstanding work in introducing plants to American horticulture. The medal was sent to Tripoli, in 1923, by the governor, Count Volpi.

Franceschi continued his literary activity to the end of his life, contributing articles on agriculture in Tripoli to the Italian journal, "L'Agricoltura Coloniale." He died in Tripoli on November 5, 1924, at the age of 81. Franceschi's oldest daughter has carried on his work in Tripoli, and today maintains a successful nursery there. She, apparently, had, in addition to a deep interest in things botanical, considerable business acumen. Probably the most important accomplishment of the two in Tripoli, has been the importation and propagation of large numbers of eucalyptus trees of various species.

HORTICULTURAL ACHIEVEMENTS

During the years that he lived in Santa Barbara, Franceschi wrote numerous articles for the local newspaper, and was a regular contributor to such journals as "Pacific Garden" and "Rural Californian." He did much toward developing an appreciation of the beauty as well as the economic value of the large number of ornamental plants and tropical and subtropical fruits that could be grown in the region. His reputation spread throughout horticultural circles in this country, and every botanist or plantsman who visited Santa Barbara, was certain to pay him a call to see his collection of rare plants. The esteem in which his judgment and opinions were held is shown by the frequency with which he is quoted in the literature of tropical and subtropical plants.

Among the multitude of new plants that he brought to the gardens of Santa Barbara, the following are some best suited to the climate there. A number of these have attained the popularity they deserve, although some, none the less fine ornamentals, are still rather rare.

Acacia obliqua	Harpephyllum caffrum
Acacia podalyriaefolia	Hibiscus heterophyllus
Aglaia odorata	Jasminum simplicifolium
Aleurites Fordii	Lippia repens
Alöe Salm-Dyckiana	Lithraea Gilliesii
Anthyllis Barba-Jovis	Lyonothamnus floribundus var.
Asparagus decumbens	asprenifolius
Asparagus scandens var. de-	Metrosideros tomentosum
flexus	Myoporum acuminatum
Bauhinia grandiflora	Myoporum tomentosum
Bauhinia tomentosa	Pithecoctenium clematidium
Bauhinia variegata	Pithecoctenium muricatum
Benthamia fragifera	Pittosporum heterophyllum
Bocconia frutescens	Pittosporum rhombifolium
Buddleia madagascariensis	Pittosporum viridiflorum
Carica quercifolia	Psidium lucidum
Convolvulus florida	Rhynchosia minima
Dioclea glycinoides	Schinus terebinthifolius
Dombeya natalensis	Schotia latifolia
Dombeya punctata	Solanum Guatemalense
Erythrina tomentosa	Sterculia discolor
Eugenia edulis	Stigmaphyllon littorale
Feijoa Sellowiana	Taxodium mucronatum
Ficus altissima	Tecoma garrocha
Ficus infectoria	Tipuana speciosa
Ficus retusa	Tricuspidaria dependens
Genista monosperma	Vitis capensis

Of all the new plants Franceschi introduced, none has become better known than *Lippia repens*. Its popularity is probably due in large part to the publicity given it by Franceschi, but the importance he attached to this particular introduction appears to have been based on an erroneous idea that he held. In 1904, in an article that he wrote for the Los Angeles Times, Franceschi states that he first introduced this species from Italy in 1898. He says: "From the Director of the Botanic Garden in Rome I obtained by mail a small tin box of *Lippia* plants, less than 12 ounces weight. Now, after six years, there are hundreds and hundreds of acres planted with *Lippia* between California, Arizona, Mexico and Australia, and it all came out of that small tin box. . . ."

In contrast to this remarkable statement, H. N. Moldenke, an authority on the Verbenaceae, in a personal communication of May 26, 1941, makes the following comment: "You can be very sure that the plants (of "*Lippia repens*") of Texas, New Mexico, and Arizona, and central, eastern, and southern United States have nothing to do with the plants introduced into California by Franceschi, but it is my belief that most of those of southern California (at least all that I have seen so far) are descendants of the ones he introduced."

The efforts Franceschi made to secure new plants, to make certain of their identity, and to obtain accurate information regarding their culture and optimum growth conditions, were often great, and show a truly scientific spirit. Scattered throughout his correspondence are letters to and from such well-known botanists as Joseph Burt-Davy, William Trelease, J. H. Maiden of Australia, Charles Sprague Sargent, Harvey Monroe Hall, Miss Alice Eastwood, and T. S. Brandegee, requesting and receiving identifications of specimens which he had submitted. As another illustration, his letter of October 30, 1908, to Mr. C. Wercklé at San Jose de Costa Rica, might be cited. Wercklé was the discoverer of *Hidalgoa Wercklei*, the "Climbing Dahlia," which Franceschi had introduced at Santa Barbara. Having had difficulty in bringing it to flower, we find him, in this letter, requesting information regarding its mode of growth and climatic requirements from the man who, logically, would know most about such matters—its discoverer. This thoroughness was typical of Franceschi.

A good example of his persistence and determination in effecting the introduction of a desirable species, is the case of *Taxodium mucronatum*, the "Montezuma Cypress." Franceschi had often seen the tree in the Botanic Garden at Naples, planted by Tenore, the botanist who described the species, and its beauty had made a lasting impression upon him. In 1898 he decided to obtain seeds and try it out in Santa Barbara, and accordingly, sent to Naples for seed, which failed to germinate. Year after year, seeds from there and elsewhere persistently refused to germinate, but at last, in 1908, after ten years of failure, his patience was rewarded. Through his friend, Professor C. Conzatti of Oaxaca, he obtained, from the Federal Park at Chapultepec, Mexico, seeds which, much to his gratification, germinated successfully. Today, many fine trees grown from these seeds may be seen in the parks and gardens of Santa Barbara.

The culture of tropical and subtropical table fruits was a subject of special interest to Franceschi. He carried on much correspondence on aspects of this subject with men of the United States Bureau of Plant Industry, and horticulturists and fruit growers (the Popenoes of Altadena, California, particularly), throughout the warmer parts of this country and of many foreign countries. He introduced several new species of *Anona*, and from a superior tree of *A. Cherimola* growing in Altadena, he raised plants in 1910 which he subsequently sent out under the name of *A. Cherimola mammillaris*. His best known fruit introduction was the "Pineapple Guava," *Feijoa Sellowiana*. This he introduced in 1901, obtaining seeds from France, where it had been introduced previously from its native South America. Although it was given much publicity at the time, *Feijoa* has not gained the popularity that Franceschi had hoped for it, and certainly has not attained any economic importance as a fruit in southern California.

Of much greater consequence in this field, however, were the frequent articles he wrote for newspapers and horticultural journals. His book, "Frutti Tropicali e Semi-tropicali," probably embodies the findings of his long years of experience in this field. It is a work of some 260 pages, contains numerous illustrations, and descriptions of 727 species. The majority of these descriptions are rather brief, although for those which are of more economic importance he gives much more detailed information. An English translation of this book from the Italian would be a real contribution to the literature of subtropical horticulture in this country.

The total number of different kinds of plants that Franceschi grew during his stay in Santa Barbara has not yet been fully worked out. Among the miscellaneous papers in the collection of his business correspondence, stored at the Herbarium of the University of California, is a typewritten list of plant names, contained on 114 sheets, with the following inscription pencilled on the first sheet: "List of Seeds and Plants Tried Out in Santa Barbara, California, by Dr. F. Franceschi." The number of genera is approximately 796, of species, varieties, and horticultural forms, approximately 2,129. Exactly what significance may be attached to this list is a questionable matter, however. There is nothing to indicate who compiled it or when this was done. It appears to have been prepared without the exercise of very much care, and in no case is information given as to the results of the trial introductions.

The total number of his new plant introductions is a debatable matter. In the catalogues of the Southern California Acclimatizing Association which he published at irregular intervals, and later, in the price lists of the Montarioso Nursery, he points out the plants that he claims were first offered by him in the horticultural trade in this country. The total number of these—species, varieties, and horticultural forms—mentioned in his catalogues and price lists from 1896 to 1914 (see bibliography) reaches nearly 900.

These claims, however, cannot all be accepted at their face value. There are occasional instances where species that he claimed to have introduced ("plants first offered by us in the United States") can be shown actually to have been offered by nurserymen prior to his coming to California. A single example is *Phoenix canariensis*, the "Canary Island Date Palm." Franceschi, in his "Condensed Catalogue and Price List" for 1908, indicates that this species was one of his introductions, but, according to Mr. H. M. Butterfield this palm was offered by John Rock at San Jose as early as 1877. Moreover, the lack of consistency with regard to some of his claims, in catalogues of different years, casts a shadow of doubt on their validity. For instance, in his catalogue for 1908, he claims to have been the first in this country to

offer the following species (among numerous others): *Cinnamomum Camphora*, *Euphorbia pulcherrima*, *Leucadendron argenteum*, *Magnolia grandiflora*, and *Persea gratissima*. In his catalogues for the years 1896, 1897, and 1900, however, he does not make this claim for any of these species, although they are all listed. However, the number of errors of this sort is probably small, although a careful check of his catalogues against earlier horticultural literature is necessary before their extent can be ascertained.

After making due allowance for these errors, the remainder is still truly remarkable. F. W. Popenoe, said of his work (*Journal of Heredity*, 13: 215, 1922) "His introductions are more numerous than those of any one man (in the United States), and many of them are now widely grown in the land of their adoption."

No evaluation of Dr. Franceschi's contributions to horticulture in this country would be complete without a consideration of the influence of his personality on those of his contemporaries with whom he came in contact. His wealth of horticultural and botanical knowledge, gained from years of travel, observation, and practical work, coupled with his untiring interest in plants, were a constant source of inspiration to plant lovers wherever he went.

The plants he introduced stand as living reminders of his untiring work, and his memory will long be perpetuated at Santa Barbara in his old home, "Montarioso," which today is a city park, named in his honor, "Franceschi Park."

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Department of Botany,
University of California, Berkeley,
May, 1941.

REVIEWS

Ceanothus. Part I. Ceanothus for Gardens, Parks and Roadsides, by MAUNSELL VAN RENSSELAER. *Part II. A Systematic Study of Ceanothus*, by HOWARD E. McMINN. Pp. xii + 308. A Publication of the Santa Barbara Botanic Garden, Santa Barbara, California. Gillick Press, Berkeley, California. 1942. \$2.50.

If there is anyone who admits the place of decorative plants in the general scheme of things but thinks that botanists—above all taxonomists and their tools, herbaria and botanical gardens—have little or “nothing to do with the case,” may he be given a copy of “*Ceanothus*”!

And may it be opened at the preface which, as G. B. S. long ago maintained is apt to be the most important part of a book. William Lassiter, Major General, United States Army, Retired, has written this one which not only reviews the work and outlines its purpose but places anyone who has anything to do with ornamental plants in the mood to desire greater use, understanding and appreciation of them.

The book is divided into two parts: the first by Van Rensselaer is devoted to a consideration of the species, alphabetically arranged, known in cultivation; the second, by McMinn is a

detailed taxonomic account of the entire genus. The former is followed by an evidently carefully considered exposition of the propagation and cultivation of these shrubs prepared by A. J. Stewart, Horticulturist of the Santa Barbara Botanical Garden, and the latter by a chapter of twenty-odd pages, entitled "Distributional History and Fossil Record of *Ceanothus*," by Herbert L. Mason. Even those primarily interested in the living plants will read Dr. Mason's lucid account of the probable evolution of the group and its species with interest because he gives a glimpse of the relationship of old floras with those of today, and by his thoughtfully interpreted observations throws light on the probable development of a number of the forms treated with doubt as distinct entities.

McMinn precedes his key to the fifty-five species and about half as many varieties (and the descriptive text) by a "General Discussion"; incidentally this includes the formal description of the genus. The discussion itself comprises about ten pages not counting some twenty more occupied by distributional maps, probable relationship charts, natural hybrid charts, chromosome "pictures" and a list of the specimens from which they were drawn (this commendable). There is also a plate depicting well the two sections into which the genus is readily divisible. The seven distributional maps are clear and conveniently show on each one several species and their variants. With the aid of these various charts the author explains, apparently with considerable confidence, his taxonomic conclusions and his reasons for arriving at them. The reviewer has no knowledge of *Ceanothus* whatsoever but anyone with general experience in classification will, it seems to him, have the impression from the author's discussion, and that of Mason, that the taxonomy even with present knowledge could have been on a sounder basis. Perhaps a number of the entities recognized as species of equal merit could have been differently evaluated considering the fact that a simple geographically limited, variable, often solitary character has frequently been accepted as "specific." However the author believes that species can be proved by experiment. Granting that this is so, it is my impression that experimental taxonomic methods, so to speak, have more often proved than disproved the fundamental soundness of specific lines and apparent relationships as they were previously suggested by the more capable botanists of yesterday and entirely from morphological and geographical data. McMinn's interest . . . I almost wrote enthusiasm . . . in "experimental methods" has, I cannot help but sense, inhibited his own expression of what he believes is actually happening (or has happened) in the history of these fascinating and plastic plants. This unfortunately (from the standpoint of practical simplicity) has resulted in his not anticipating facts (as he hints himself, for example page 191 and elsewhere) that the methods he advertises will probably at least in many cases be able to prove. In any

case his keys and remarks are clear, and others can follow his reasoning. His obvious knowledge of the group is little short of amazing even with due appreciation of his indebtedness to the work of previous students, notably Jepson and the latter's pupil, J. T. Howell. To the former he pays the compliment of using his method of citation of references and specimens. In this connection one may remark the excellent, distinctive typography. There is a lovely color plate of *C. purpureus* and innumerable photographs uniformly of exceptional beauty and value as well as a number of good drawings.

Finally let us turn to the descriptive account of the seventy-odd species and a number of varieties distinguished by Van Rensselaer in cultivation. He describes them in the idiom of the horticulturist, usually adding some remarks as to distribution, where cultivated and the growing conditions required. It would have been desirable if, besides the index to the entire book, page references after the descriptions had been given in each part to the other part. In this case some discrepancies in names used for the same plants would have been discovered. For example on page 14 we find the name *C. austromontanus* instead of *C. foliosus* in which it is included by McMinn, page 223. On page 30 the name *C. exaltatus* is given as "a new horticultural designation" while McMinn ignores it except as a variety of *C. gloriosus, et cetera*. Some of these slips, or they may be differences in opinion between the two authors, are going to confuse if not anger bibliographers, not to mention certain professional botanists who, of course, are almost God-like in the perfection of their own work!

Above the rare mistakes, here is a living work, jointly conceived, jointly prepared, inspiring to everyone whether amateur or professional in the garden, herbarium or laboratory, and creating a closer bond of understanding, of friendship between all who have to do with plants, as Major General Lassiter has happily phrased it. The contributors who made the book possible are to be congratulated and thanked for supporting so worthwhile a project that is destined to become a classic of its kind. Humanity needs many similar books and from them will be born the realization that adequately financed herbaria and gardens must always be the basis for them.—J. FRANCIS MACBRIDE, Field Museum of Natural History, Chicago.

Practical Plant Anatomy. By ADRIANCE S. FOSTER. Pp. 1-155. D. Van Nostrand Company, Inc., New York. 1942. \$2.50.

This compact book of fourteen chapters or "Exercises" is spirally bound in flexible fabrikoid. Each exercise consists of a brief but accurate résumé of both early and recent papers dealing with the subject of the chapter, some discussion of the subject matter and different points of view thereon, and suggestions for study of selected materials and drawings to be made by the student. A short but well-chosen bibliography completes each

exercise. The book is primarily a laboratory guide for a course in plant anatomy, although the discussions contain much factual material not usually included in a strictly laboratory guide.

The suggestions for study, the material recommended, and the diagrams and drawings which the student is supposed to make, are all thoughtfully handled. The author has succeeded in reducing the number of drawings required to a minimum, a feature that will be welcomed by the immature students who want to confine their laboratory work to a definite, set period. This feature is not as reprehensible as it might seem to some proponents of many drawings, for *diagrams* are substituted for the tedious, time-consuming detailed drawings to show relationships among various tissues. Of course, any student interested in making numerous detailed drawings of cellular types will find adequate hints throughout the text if he looks for them! The total absence of figures and illustrations mitigate against the use of the book as a guide to a study of plant anatomy by those who are unable to work under the direction of a trained instructor or where the library facilities do not afford extensive reference works.

No attempt was made to give directions for the preparation of permanent microscope slides. But a far better point of view has been taken in that free-hand, temporary mounts of fresh materials are called for in nearly every exercise. No student using this method will get the idea that xylem is always stained red and that phloem and parenchyma cells are characterized by an affinity for a blue or green stain! Brief directions for macerating woody tissues and for the use of a few special reagents are included in the short appendix. The index is gratifyingly complete.

The method of approach is analytical and classificatory rather than phylogenetic. The author's reason for thus avoiding controversy is well stated in the following excerpt from Exercise IV (p. 39): "Since all methods for classifying plant tissues are open to objection, the writer has adopted a non-committal and 'practical' attitude in this book. Instead of following any one scheme of classification, the emphasis is placed first of all upon the salient morphological features of the *principal types of plant cells*. These cell types recur in various regions, 'tissues' and organs of the higher plants, and a thorough knowledge of their form, structure, development, and presumable function(s) must constitute the necessary analytical approach to anatomy."

The format and typography is good and errors are extremely few. The fabrioid cover helps to protect the book from damage where liquids may be spilled on the laboratory table and the spiral binding permits the book to lie flat when opened to any page. The numerous references in the text and the bibliographies following each exercise hold valuable keys to voluminous literature on plant anatomy.—IRA L. WIGGINS, Stanford University.

John Torrey, a Story of North American Botany. By ANDREW DENNY RODGERS III. Pp. 1-352. Princeton University Press, 1942. \$3.75.

Mr. Rogers has included in one volume an amazing wealth of information on the history of botanical exploration in North America. He is to be congratulated on presenting such a comprehensive picture of the life of John Torrey. Torrey, professor of chemistry at Columbia and Princeton, was by avocation a botanist. Through his pioneering efforts, the systematization of the flora of this continent was begun. He arranged and described the collections of numerous individuals and expeditions—Fremont, Emory, Owen, Whipple, Ives, the Mexican Boundary Survey, the United States Exploring Expeditions, and many others. He was founder of the Torrey Herbarium, now housed at the New York Botanical Garden, and of the United States National Herbarium. His influence was extended by his association with the foremost botanists of his time, one of his first proteges being Asa Gray. The large amount of material from original sources which is made generally available for the first time in this book is intensely interesting as well as invaluable to a study of the history of botanical exploration.—MILDRED MATHIAS, Department of Botany, University of California, Berkeley.

Geographical Guide to the Floras of the World. Part I. By S. F. BLAKE AND ALICE C. ATWOOD. United States Department of Agriculture, Miscellaneous Publication 401, pp. 1-336. Washington, D. C. June, 1942. \$0.75.

Here is the first part of a catalogue, unique in its field, that is destined to become one of the most useful books in the entire science of botany. Its value has been adequately demonstrated to the reviewer many times during the short time that the book has been in his possession. The work is a bibliographic catalogue listing in geographic order the floras and floristic accounts of the various geographic units of the world. In general, only complete works are included, but for little known regions collector's lists are sometimes cited. Both general and local floras are included and most of the entries are annotated to indicate the content of the work. Part one deals with Africa, Australia, insular areas, North America and South America. To the authors are due the thanks of the entire botanical profession for performing so well a task that doubtless entailed much drudgery.

It is to be hoped that this work may serve as a stimulus to inspire some bibliographically inclined individual to compile and publish a companion volume which will guide students to the literature dealing with taxonomic accounts, in whole or in part, of the families and genera of the flowering plants.—HERBERT L. MASON.

Eriocaulaceae, Avicenniaceae, Verbenaceae. By HAROLD N. MOLDENKE, in *Flora of Texas*, edited by C. L. Lundell. Vol. 3, pt. 1, pp. 1-87. University Press in Dallas. Southern Methodist University. 1942. \$1.50.

This is the first part to be published of a proposed "... 10-volume work, each volume to contain approximately 700 pages. Volume 1 and 2 will contain the history of botanical exploration, the key to the families, a catalogue of all species, and maps showing distribution according to counties." The proposed work is unlike most modern floras in that each part will be a complete monographic unit in itself and will not, apparently, be arranged in taxonomic sequence by families.

This first part by Dr. Harold N. Moldenke, of the New York Botanical Garden, is notable for the length of the generic and specific descriptions, complete synonymy, citation of numerous specimens, and extensive (probably complete) citation of references to publications where the species have been treated by earlier authors. The number of specimens cited for each family, together with an enumeration of the herbaria where they are deposited, is given in a footnote below each family description.

The keys to genera and species are dichotomous and separate varieties as well as species. In most instances they use qualitative rather than quantitative characters, but sometimes make use of geographic ranges to supplement comparatively weak morphological characters.

Brief but interesting comments deal with vernacular names, geographic ranges, relationships, earlier misidentifications and uses by aborigines and the early settlers.

The paper is of good quality and the printing clean-cut. Typographical errors are few. Both the taxonomic and editorial work seem to have been done thoroughly, although Dr. Moldenke appears to draw specific lines pretty finely.

The publication of this monograph of the three families as they are represented in Texas initiates an ambitious project which will be watched with interest by all plant taxonomists. Dr. Lundell is to be congratulated for undertaking to see through the tedious processes of writing and printing a work that will fill a long felt need—an adequate and exhaustive flora of the Lone Star State. It will be a source of great satisfaction to taxonomists if the high standards established in this initial publication hold throughout the entire work. It is the hope of the reviewer that Dr. Lundell may be able to secure the aid of enough collaborators to push the series through to completion within a reasonable length of time.—IRA L. WIGGINS, Stanford University.

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ETHEL KATHERINE CRUM

It is with regret that we announce the death of Miss Ethel Crum, Secretary to the Editorial Board of Madroño and Assistant Curator of the Herbarium of the University of California. She passed away on January 5, 1943, at her family home in Lexington, Illinois. Her botanical career began with the attainment of the degree of Master of Arts at the University of California in 1929 and her appointment as research assistant to Dr. W. L. Jepson at the time that the manuscript for volume two of "A Flora of California" was in preparation. She assisted in the organization of the material for many of the larger genera in this volume but adopted as her own, the genus *Potentilla*, the manuscript of which was accepted with some revisions. Further evidence of her work may be noted in the Capparidaceae and in the Leguminosae. In 1933 she accepted a position on the curatorial staff of the Herbarium of the University of California where she remained until her death. Here, in addition to her duties, she interested herself in the genera *Monolopia* and *Pseudobahia* and for the Editorial Board of Madroño she assumed the burden of editing and preparing manuscript for the printer. It is in this capacity that she made her most significant contribution to botany. Her early training in the classics, her command of the English language and her experience in handling manuscript combined to make her particularly suited to these tasks.

Her ideas of editorial procedure were well conceived and fairly consistently adhered to. She believed that the first function of an editor of a botanical journal is to protect the author from himself by preventing him where possible from making hasty and unconsidered statements, from being misinterpreted or misunderstood because of his lax use of grammar and from injecting personalities into an article to the point of creating offense. She edited to reduce the hazards of future embarrassments to the author.

She had a positive concept of where the rights of the author leave off and the rights and duties of the editor begin. These rights fluctuated only with the age and experience of the author. She believed, for instance, that the text of a manuscript, while subject to such editing as is necessary to make it conform to the style of the journal and the standard of fitness set by its editors, is the concern of the author and when once the article is accepted by the editors any changes affecting the argument or conclusions may have the effect of impeaching the author and are wholly unjustified. On the other hand, the precise wording of the title of an article should be left to the editor subject to suggestion and approval by the author. This concern stemmed from experience in the use of bibliographies wherein a tremendous amount of time is wasted investigating the subject matter of articles whose titles

MADROÑO, Vol. 7, pp. 33-64. April 28, 1943.

are inadequate or misleading. She insisted that a title should be sufficiently specific to indicate not only the subject of an article but something of its scope. She insisted that it should be expressed in language that can be readily translated into any foreign tongue and still convey its precise meaning. This entails the elimination from the title of all abbreviations and all forms of speech that are colloquialisms or professionalisms.

As to the use of footnotes, it was her firm conviction that anything worth saying in a footnote was worth incorporating into the text. Footnotes, she maintained, interrupt the continuity of thought of the reader and in addition spoil the appearance of the printed page. They should, therefore, be avoided or reduced to emergency use.

She believed that articles on isolated nomenclatorial problems were largely a waste of time and space and constantly urged the Editorial Board to adopt a rule refusing to print them unless they were written in conjunction with a monograph of the group concerned or were being used to urge the necessity of changes in or additions to the rules of botanical nomenclature. It was her further conviction that the available space in any journal is too precious in these days to waste it on preliminary taxonomic revisions and that no revision is worthy of publication until the author has completed his work upon it. She deplored the word "preliminary" because it is often taken as a promise of a more complete treatment to follow, whereas the author is content to allow his decisions to rest with the preliminary account. She argued that if the author intended that the account would be final then his use of the word "preliminary" in the title becomes a form of dishonesty and can only be construed as an excuse to cover mistakes and decisions resulting from inadequate study.

She continually urged upon young authors the avoidance of making in print promises as to the publication of future researches. Too often circumstances do not permit the fulfillment of such promises and the fact that they have been made may cause some investigator to make fruitless search of the literature. On behalf of the training of youthful and inexperienced authors she was a crusader; she would spare no effort to see to it that they were at least shown the paths of righteousness. Most of them responded in good taste and evidenced a sincere appreciation of her efforts to help them. A few have become soured on editors for life.

Her work on Madroño has set a standard of excellence in editorship the maintenance of which will serve as a challenge to her successors. She, perhaps more than any other person, has influenced its recent editorial policy.

Miss Crum was born in Lexington, Illinois, on March 13, 1886. She was educated at the University of Illinois and graduated with the class of 1907. Her education stressed English literature and

the classics. From 1909 until 1929 she taught in the public school systems of America, an experience of which she spoke as "traversing an intellectual desert of the most barren sort." This may serve to explain better than more precise words her reasons for shifting her career to botany. During the years from 1932 to 1938 she served as Secretary of the California Botanical Society, relinquishing these duties to devote more time to her work as Secretary to the Editorial Board.

Upon acquaintance one soon became impressed with the fact that Miss Crum was a woman of outstanding intellectual brilliance, that she had an engaging personality and a ready flow of wit and humor. She was devoted to her work and her several hobbies crowded one another for her attention. Her passing ends a career of uncommon usefulness; her life was a milestone in the history of a journal.—HERBERT L. MASON.

THE XEROPHYLLOUS SPECIES OF PHILADELPHUS IN SOUTHWESTERN NORTH AMERICA

C. LEO HITCHCOCK

There are, in southwestern United States and northern Mexico, several species of *Philadelphus* which are xerophytic. These plants have a rather heavy indumentum on the lower surfaces of the leaves as well as on the calyces and on the epidermis of the twigs. Their leaves are small (1–3 cm. long), rather thick and leathery, and entire. Whereas the flowers of *Philadelphus* are usually borne in cymes or panicles of from three to many blossoms, the flowers of these members of the genus usually occur singly (rarely in two's or three's) at the ends of short leafy lateral branches. They have been placed in the group *Microphylli* by Rydberg (No. Amer. Fl. 22: 163. 1905) with no indication whether this group is of sectional or subgeneric rank. Since the precise taxonomic status of this and corresponding groups of the genus is not pertinent to this paper, the term "group" which was frequently used by Rydberg will be used.

Floristically, these small-leaved species are particularly interesting, since they occur chiefly in the lower levels of the larger mountain ranges from Texas to California. Since localized populations of each of the species are isolated by intervening deserts, geographical races have become differentiated from one another. As a unit they are readily distinguished from all other North American species of *Philadelphus*, yet it is quite apparent that they have been derived from, and are very closely related to, certain species of the *Mexicani* (Rydb. op. cit.). A general idea of the relationship of these sections as well as the geographic distribution of the *Microphylli* is expressed in the accompanying diagram (fig. 1).

Of the various species in the *Mexicani*, *Philadelphus affinis*

and its inflorescence is a five- to eleven-flowered cyme. In general appearance it is very suggestive of the species of *Californici*, *Coronarii*, and *Grandiflori*. Another species of the same group, *P. mexicanus*, is quite similar to *P. affinis* in most particulars, but the plant is more pubescent and the inflorescence is greatly reduced, usually consisting of one, or of three, flowers at the ends of short lateral branches. A third species, *P. Coulteri*, has much smaller leaves (3-6 cm. long) which are more leathery and, although denticulate, are very densely hairy; the petals are considerably smaller (12-17 mm. long) and the inflorescence is usually one-(three-)flowered. The styles are densely hairy as is the upper part of the ovary.

Philadelphus Purpusii (*Microphylli*) although known from only one collection, is a well-marked species that is apparently closely related to *P. Coulteri*, having leathery, hairy leaves, and flowers that are quite similar to those of its supposed relative, but differing in that it has entire, small (2-3.5 cm. long) leaves, petals that are but 10-15 mm. long, and sparsely hairy styles. *Philadelphus microphyllus*, with its various subspecies, has apparently been derived from *P. Purpusii*, probably through the subspecies *argyrocalyx*, *argenteus*, and *crinitus*, all of which have the pubescence and leaves characteristic of *P. Purpusii*. In the first two of these subspecies there is even a trace of the pubescence of the styles and ovary that characterizes *P. Purpusii* and *P. Coulteri*.

The relationship of *P. serpyllifolius* and *P. Mearnsii* to the other species of *Microphylli* is not so apparent, but it is possible that they have been derived from *P. microphyllus*.

From the map it can be seen that the two subspecies of *Philadelphus Mearnsii* apparently are widely separated geographically. It seems probable, however, that more thorough collecting in northern Mexico will disclose that the plants are much more widely distributed than extant collections indicate. The typical form of the species was collected in 1892 and it was not until 1924 that the next collection was made, and that in a region remote from the type locality. Only two collections have been seen that were made since 1924, yet it seems certain that the plant is to be found in other parts of New Mexico, Texas, or Mexico.

The presence of what I consider to be a local population of *P. microphyllus* subsp. *typicus* in the Chisos Mountains of Texas is difficult to explain. As mentioned under the treatment of that subspecies, however, it is strongly suspected that these plants are really genetically different from the plants in central New Mexico, but aside from the fact that they are much greener in aspect, distinctive taxonomic characters are not discernible from the herbarium material examined.

Until the treatment of the genus by Rydberg in 1905, but few specific names had been proposed in the group. Rydberg not only recognized five species that had been described previously

but proposed seven additional specific entities. Since his work one or two additional names have been proposed. It was with the hope of evaluating the validity of these various species that this study was undertaken.

Herbarium material has been made available to me from the following institutions, their abbreviations, as I have used them in citing material, being shown in parentheses. University of California (C), Gray Herbarium (G), New York Botanical Garden (NY), Pomona College (P), Stanford, Dudley Herbarium (S), United States National Museum (US), University of Washington (Wash), State College of Washington, Pullman (WSC). To the curators of these herbaria I express my sincere appreciation.

KEY TO SPECIES

- A Lower surfaces of leaves grayish with short matted tomentum and (usually) longer straight appressed hairs; stamens mostly 28 (26-32 or more ?); styles less than 1 mm. long 3. *P. serpyllifolius*
- AA Lower surfaces of leaves green or grayish but never with tangled matted tomentum; stamens and styles various.
 - B Base of styles and adjacent ovary densely pilose; leaves coarsely strigose on both surfaces; calyces gray 4. *P. Purpusii*
 - BB Base of styles and adjacent ovary glabrous or (very rarely) with few hairs; leaves and calyces various.
 - C Stamens 16-24, filaments distinct; styles less than 1 mm. long; pubescence of leaves very coarse, the hairs thick in cross section 2. *P. Mearnsii*
 - CC Stamens more than 25, filaments often united at the bases; styles usually at least 1 mm. long; pubescence of leaves of slender hairs 1. *P. microphyllus*

1. *PHILADELPHUS MICROPHYLLUS* Gray, Mem. Am. Acad. Sci. II, 4: 54. 1849.

Much branched, rounded shrub 1-2 m. tall; young branches densely pubescent with appressed hairs, often silvery, bark more or less reddish-brown to tan, usually exfoliating the second year, older branches grayish to grayish-brown; petioles 1-3 mm. long, leaf-blades ovate, ovate-lanceolate, or lanceolate, to lanceolate-elliptic, 8-35 mm. long, 3-15 mm. broad, entire, often slightly revolute, the apices rounded to acute, 3-nerved from base, pubescent with hairs that are minutely papillate their entire length, the upper surfaces either strigose with closely appressed hairs or hirsute with short erect hairs, but sometimes both strigose and hirsute, rarely glabrate, lower surfaces usually more densely hairy, the hairs either fairly long and partially appressed, or shorter, straight, and closely appressed; flowers borne singly or in threes (twos) on pedicels 0.5-3 mm. long, at ends of short leafy shoots;

calyx-tube 2-3 mm. long in flower, enlarging to 3-5 mm. in fruit, sparsely to densely strigose (glabrate), less commonly quite silvery with dense indumentum of tangled somewhat curled hairs, lobes 3-5 mm. long, acute to acuminate, outer surface glabrous to pubescent like the tube, inner surface always lanate; petals white to cream, 6-17 mm. long, usually rounded but often emarginate; stamens (30) 32 to about 70, the filaments usually partially united at least at base, but sometimes entirely free; styles (0.5) 1-2 mm. long, free above, or more commonly, united to tips; stigmas 1.5-3 mm. long, usually partially united.

Philadelphus microphyllus has been treated taxonomically in various ways. Many authors, like Rydberg, considered the plant as it occurs in central New Mexico to be specifically distinct from the many closely related forms of California, Nevada, Utah, and Arizona. It is true that it is largely a matter of interpretation whether these other entities be considered varieties, subspecies, or species, but certain characteristics upon which Rydberg based his species appear to me to be but normal variations largely accountable for by habitat. Still other differences which were used to characterize some of these segregates are not at all constant even though they may be genetic in origin, so that the maintenance of some of Rydberg's species, even as subspecific entities, does not seem feasible. One such characteristic is that of the degree of union of styles and stigmas. Although there is some variation in the length of the styles and in the degree to which they are united, I can find no consistent variation which can be correlated with other distinctive morphological characters or with geographical distribution. In some cases the styles of different flowers on the same specimen may be "united" and "partially free" (*Hitchcock et al.* 4148, C).

Although Rydberg listed definite and distinctive numbers of stamens for several of his closely related species (*P. stramineus* 30-40, *P. microphyllus* ca. 40, *P. minutus* ca. 60, *P. pumilus* ca. 30, and *P. argyrocalyx*, *P. ellipticus* and *P. occidentalis* "many"), the stamens are so inconstant in number that species cannot be distinguished in this manner. The normal number of stamens is seemingly a multiple of four, *P. stramineus*, for example, may have anywhere from thirty to forty, but usually has thirty-two, whereas *P. occidentalis*, *P. argenteus*, and *P. argyrocalyx* usually have from forty to sixty. There is often some variation in the stamens of flowers of the same branch, so that neither *P. pumilus* nor *P. stramineus* can be maintained on the basis of this character alone.

Leaf size, too, varies greatly, but the variation appears to be due chiefly to the age of the branch on which the leaves are produced or to the amount of shade in which the plant grows. As would be expected, plants which have grown in partial or complete shade have large leaves and rather sparse pubescence. The variation in leaf size due to branch age is best shown, perhaps, on

a plant collected by Rydberg and Garrett (no. 9608). The leaves of a young shoot are well over 3 cm. in length, those of an older shoot are scarcely 1.5 cm. long. In a Heller and Heller collection (no. 3792) nearly all plants have leaves from 2.2 cm. to 3.5 cm. in length; however, the sheet at Stanford bears a plant with leaves less than 2 cm. long. Another collection (Harrison 6604) made from a plant with leaves 6 to 8 mm. long had a two to three year old branch with leaves 9 mm. long. The three twigs of this branch bore new growth with leaves all 12 to 19 mm. long.

I can see no significant variations in the color, pubescence, or degree of exfoliation of the bark. It seems, therefore, that the characters that are dependable for subspecific delimitation are the following, listed in order of significance: type and amount of pubescence, number of stamens, leaf size, and flower size.

KEY TO SUBSPECIFIC VARIATIONS OF *P. MICROPHYLLUS*

- A Petals with large purple spot at base 1b. *P. microphyllus*
subsp. *maculatus*
- AA Petals not spotted with purple.
 - B Calyx-tube silvery, completely covered with long hairs.
 - C Pubescence of calyx matted, consisting of long straight hairs mixed with more slender intertwined hairs; leaves rather densely pubescent, the hairs of lower surfaces rather long and often not appressed, the upper surfaces much less pubescent and usually greenish 1d. *P. microphyllus*
subsp. *argyrocalyx*
 - CC Pubescence of calyx usually not matted, but if so, the hairs all of same type, often the pubescence too sparse to be tangled.
 - D Calyx shaggy with long matted slender hairs; both surfaces of leaves grayish with long slender hairs, these sometimes somewhat matted on the lower surfaces 1c. *P. microphyllus*
subsp. *crinitus*
 - DD Calyx with appressed pubescence chiefly, the hairs not tangled; leaves mostly distinctly greenish above, if grayish the hairs not at all matted.
 - E Upper surfaces of leaves with hirsute pubescence, the hairs erect or nearly so.
 - F Stamens usually 40 or more; leaves mostly over 15 mm. long, the pubescence of lower surfaces not tightly appressed 1d. *P. microphyllus*
subsp. *argyrocalyx*

FF Stamens usually 32; leaves often less than 15 mm. long, the pubescence of lower surfaces rather tightly appressed.

G Hairs of upper surfaces of leaves all essentially of the same length . . .

1f. *P. microphyllus*
subsp. *stramineus*
forma *zionensis*

GG Hairs of upper surfaces of leaves mainly short and erect, the remainder less numerous, longer and more appressed .

1g. *P. microphyllus*
subsp. *pumilus*

EE Upper surfaces of leaves with strigose pubescence, the hairs appressed.

H Stamens usually 40 or more, some usually united half their length; leaves mostly over 15 mm. long . .

1a. *P. microphyllus*
subsp. *argenteus*

HH Stamens usually 32, free or united only at base; leaves seldom over 15 mm. long . . .

1e. *P. microphyllus*
subsp. *stramineus*

BB Calyx-tube not silvery, or at least not completely covered by pubescence.

I Leaves hirsute above, the hairs erect or nearly so.

J Leaves usually 8-12 mm. long, the pubescence of lower surfaces of appressed hairs, that of the upper surfaces consisting of many short erect hairs mixed with less numerous, longer, subappressed hairs

1g. *P. microphyllus*
subsp. *pumilus*

JJ Leaves 8-30 mm. long, the hairs of lower surfaces not appressed, or those of the upper surfaces all of one type.

K Stamens usually 40 or more; leaves commonly at least 15 mm. long, the hairs of lower surfaces not always tightly appressed

1d. *P. microphyllus*
subsp. *argyrocalyx*

KK Stamens usually about 32 (to 40); leaves 8-15 mm. long, the hairs of lower surfaces appressed

1e. *P. microphyllus*
subsp. *stramineus*

II Leaves not hirsute above, the hairs appressed.

L Petals 11–17 mm. long; hypanthium with but little pubescence, this chiefly at the angles

1h. *P. microphyllus*
subsp. *typicus*

LL Petals seldom over 10 mm. long; hypanthium various but often quite densely pubescent.

M Filaments usually united at least one-third their length; calyx-tube silvery; leaves mostly 20–30 mm. long, not hirsute . . .

1a. *P. microphyllus*
subsp. *argenteus*

MM Filaments free or united at base only; calyx-tube not silvery, or if so, leaves usually less than 20 mm. long.

N Stamens usually about 32; entire outer surface of calyx quite densely pubescent with stiff straight appressed hairs, the outer surface almost completely covered by hairs

1c. *P. microphyllus*
subsp. *stramineus*

NN Stamens usually 40 or more; the outer surface of calyx sparsely pubescent or even partially glabrous, in any case not hidden by hairs

1i. *P. microphyllus*
subsp. *occidentalis*

1a. *PHILADELPHUS MICROPHYLLUS* subsp. *argenteus* (Rydb.) comb. nov. *P. argenteus* Rydb. N. Am. Fl. 22: 171. 1905. *P. argyrocalyx* var. *argenteus* (Rydb.) Engl., Engl. & Prantl, Nat. Pflanzenf. II, 18a: 193. 1930. *P. microphyllus* var. *argenteus* (Rydb.) Kearney & Peebles, Journ. Wash. Acad. Sci. 29: 480. 1939. *P. Palmeri* Rydb. N. Am. Fl. 22: 173. 1905; type: Sierra Madre, 40 miles south of Saltillo, Mexico, *Palmer 2122*. *P. madrensis* Hemsl. Kew. Bull. 251. 1908; type: Sierra Madre, Durango, Mexico, *Seemann 2167*.

Leaves mostly 20–35 mm. long, ovate-lanceolate or lanceolate, pubescence of lower surfaces grayish-strigose, upper surfaces sometimes glabrate; calyx more or less canescent with long straight appressed hairs which are often mixed with shorter more slender ones; petals 8–11 (12) mm. long, often pubescent on outer surfaces near the base; stamens 40 or more, filaments usually united at least at the base and often united to near the

tip, usually grouped in irregular phalanges; styles sometimes sparsely hairy near base.

Type. Fort Huachuca, Arizona, *Dr. T. E. Wilcox* in 1893.

Range. Mountains of southeastern Arizona, south into Sonora, Chihuahua, Coahuila, and Durango, Mexico.

Material seen. ARIZONA. Coronado Mts., *Goldman* 2379 (US); Santa Rita Forest Reserve, *Griffiths* 4194 (US). Santa Cruz County: near Patagonia, *Harrison* 7180 (C, NY). Cochise County: Bisbee, *Carlson* in 1915 (US); Fort Huachuca, *Wilcox* in 1893, type collection (NY), *Wilcox* in 1873 (NY), probably should read 1893, surely part of type collection; *Wilcox* in 1892 (NY), and *Wilcox* 234 (US); Huachuca Mts., Ramsey Canyon, *Jones* 24913 (P) and Millers Canyon, *Goodding* 147 (G, NY, US); between Fort Huachuca and San Pedro River, *Mearns* 1540 (US); Chiricahua Mts., Barfoot Park, *Blumer* 1303 (G, NY, S, US); Barfoot Fire Station, *Eggleston* 10766 and 10794 (US); Upper Pine Canyon, *Burrall* in 1906 (US); Dos Cabezas, *Lemmon* in 1881 (C). Graham County: Mt. Graham, *Peebles, Harrison, & Kearney* 4449 and 4450 (US). Pima County: Santa Catalina Mts., *Lemmon & Lemmon* in 1881 (C); Santa Rita Mts., *Pringle* in 1881 (G, NY, P, US) and *Peebles & Harrison* 3000 (US); Rincon Mts., Spud Range, *Blumer* 3565 (C). MEXICO. CHIHUAHUA: Guayanopa Canyon, Sierra Madre Mts., *Jones* in 1903 (P); San Luis Mts., *Goldman* 1432 (US). SONORA: San Jose Mts., *Mearns* 1617 (US). COAHUILA: Sierra Madre, 40 miles south of Saltillo, *Palmer* 2122, type collection *P. Palmeri* (G); Sierra de Parras, *Purpus* 4592 (G, US).

Philadelphus microphyllus subsp. *argenteus* approaches subsp. *stramineus* and subsp. *pumilus* in the pubescence of the calyx, but is larger-leaved than either and the pubescence of the leaves is all appressed. It is also quite similar to subsp. *argyrocalyx* but differs because the leaves are not hirsute, their lower surfaces have more appressed pubescence, and the pubescence of the calyx is more uniform.

There is scarcely any difference between the type of *P. Palmeri* and the type of subsp. *argenteus* except that the filaments are more completely united in the former. Pubescence, leaf size and shape, and flower size are alike in the two. Rydberg surely had seen only the type specimen when he described *P. Palmeri*, but the Purpus collection, made in 1910, is annotated by Rydberg as *P. Palmeri* and shows that he must have had to change his concept of the species considerably, since the flowers of that collection have petioles that are but 1.5 mm. long (original description of *P. Palmeri* specified 1.5 cm., although this is probably a typographical error), petals that are 9–12 mm. long (12 in original description), styles that are *not* distinct, and a hypanthium that is as long as it is in most of the other subspecies of the complex. The only possible basis for maintaining *P. Palmeri* even as a sub-

species would be the union of the filaments. However, much of the material from Arizona that is surely *P. argenteus* has filaments as completely united as are the filaments of the flowers of the two collections of *P. Palmeri* (Pringle in 1881, Santa Rita Mts., and Blumer 1303).

Philadelphus madrensis is being reduced to synonymy even though the type (Seemann 2167, Sierra Madre, Durango) has not been seen. That plant, it will be noted, was collected very near the type locality of *P. Palmeri*, and the original description of *P. madrensis* fits *P. Palmeri* quite well. The "1-3-flowered inflorescence, and sessile, acute, entire, 3-nerved, sericeous-pilose leaves" are similar to those of the type of the latter species and therefore to those of subsp. *argenteus*. There is nothing distinctive about the flowers, the stamens being more or less connate into four phalanges and the ovary either glabrous or slightly pilose on top. In fact one could scarcely compose a description that would apply more closely to *Philadelphus microphyllus* subsp. *argenteus* than does the description of *P. madrensis* except that the stamens are said to be about thirty-two, whereas in the specimens of *P. argenteus* I have seen there have been forty or more. This discrepancy notwithstanding, it seems safe to assume that *P. madrensis* is identical with *P. Palmeri* and therefore with subsp. *argenteus*.

There is the possibility that this is the same plant as *P. asperifolius* (Koern. Gartenflora 16: 73. 1867) but in the absence of proof of this identity, that name is not being used. Rydberg's separation of *P. asperifolius* on the basis "bark of previous year's growth not exfoliating" is inconclusive.

1b. *PHILADELPHUS MICROPHYLLUS* subsp. *maculatus* subsp. nov.

Foliis lanceolatis vel ellipticis-lanceolatis, 1.5-2.5 cm. longis, ca. 4 (3-8) mm. latis, viridis, appresso-pubescentibus; calicibus purpureis, cum pilis adpressis tenuibusque pubescentibus, cineraceis, tubo ca. 3.5 mm. longo, lobis 4-5 mm. longis, abrupto-acuminatis; petalis oblongo-ovatis, ca. 12 mm. longis, albis, petalo inferiore purpureo-maculato; staminibus 32-40, plus minusve in phalangibus ex 2-8 filamentis conjunctis, interdum ad proximum apicem connatis; stigmatibus ca. 3 mm. longis, saepe absoluto-connatis; stylis ca. 1.5 mm. longis, ad basum sparse pilosis.

Leaves lanceolate to elliptic-lanceolate, 1.5-2.5 cm. long, ca. 4 (3-8) mm. broad, both surfaces greenish, the pubescence appressed; calyces purple, finely appressed pubescent and rather cineraceous, the tube ca. 3.5 mm. long, the lobes 4-5 mm. long, abruptly acuminate; petals oblong-ovate, ca. 12 mm. long, white with distinct purplish blotches at base, sometimes with this purple spot extending to upper half or even to tip of petal; stamens 32-40, irregularly united into phalanges of 2-7 or 8 filaments, these sometimes connate to near tip; stigmas ca. 3 mm. long, usually

completely united, styles *ca.* 1–5 mm. long, sparsely strigose at base.

Type. In forest of large pines, forest floor of low vegetation, mountain top, 7 kilometers southwest of Miquihuana, Tamaulipas, Mexico, lat. 23° 42' N., long. 99° 45' W., elev. 3430 m., August 5, 1941, *Stanford, Retherford, and Northcraft 690* (Wash).

This showy-flowered form of *Philadelphus microphyllus* is closely related to subsp. *argenteus*, but differs not only in the purple-spotted petals, but also in the narrower, greenish leaves. This greenness may be due, in part at least, to the fact that the plants were probably partially shaded.

It is known only from the type collection but the collectors report that it was fairly abundant, that all plants seen had the spotted petals, and that their collection, of about ten herbarium sheets, was made from about four different shrubs.

1c. *PHILADELPHUS MICROPHYLLUS* Gray subsp. *crinitus* subsp. nov.

Folia 15–25 mm. longa, supra alba, adpressa-strigosa, subtus simplicatio-strigosa, calicibus extra albis implicatis-strigosis; petalis *ca.* 11 mm. longis; staminibus 48–68, filamentis basi connatis; stylis 1–1.5 mm. longis, connatis; stigmatibus connatis.

Leaves mostly 15–25 mm. long, pubescence of the upper surfaces grayish, strigose, the hairs appressed, pubescence of the lower surfaces densely long strigose, the hairs often somewhat tangled; calyces gray with long more or less matted slender hairs; petals *ca.* 11 mm. long; stamens 48–68, united at base; styles 1–1.5 mm. long, united; stigmas 3–4 mm. long, united.

Type. Rocky ground near top of Mount Livermore, Davis Mountains, Jeff Davis County, Texas, June 4, 1928, *E. J. Palmer 34347* (NY).

Other material seen. TEXAS. North side Mount Livermore, *Palmer 34364* (NY); Livermore Peak, *Ferris & Duncan 2529* (NY, S).

The status of this entity is puzzling. By some workers it has been mistaken for *P. serpyllifolius*, but it differs so markedly from that species in pubescence, stamen number, style and stigma length, and general appearance, that a close relationship between the two seems doubtful. It is probable that it is much more closely related to *P. argyrocalyx* or even to *P. argenteus*, both of which it strongly resembles in general aspect, but the pubescence of the calyx and leaves is so unique that it cannot be combined with either. Since the flowers are so like those of the other subspecies of *P. microphyllus* there is not an adequate basis for according the plant specific recognition.

1d. *PHILADELPHUS MICROPHYLLUS* subsp. *argyrocalyx* (Wooton) comb. nov. *P. argyrocalyx* Woot. Bull. Torrey Bot. Club 25: 452. 1898. *P. serpyllifolius* var., Gray, Pl. Wright. 2: 64. 1852. *P. ellipticus* Rydb. N. Am. Fl. 22: 172. 1905; type: Mesilla Park,

New Mexico, *Tinsley* in 1896, probably wrong locality (Woot. & Standl., Contr. U. S. Nat. Herb. 19: 300. 1915).

Much like subsp. *argenteus* in general appearance but leaves hirsute on upper surfaces and usually with less appressed, but somewhat longer, looser, hairs on lower surfaces; calyces typically grayish with matted mixture of long straight and slender curled hairs, but pubescence sometimes less abundant and calyces then scarcely grayish; petals 8–11 (17) mm. long, often pubescent near base on the outer surfaces; stamens usually 40 or more, filaments commonly partially united, often united to near tips; styles united, sometimes sparsely hairy near base; stigmas at least partially united.

Type. Eagle Creek, White Mountains, Lincoln County, New Mexico, *Wooton 524*.

Range. Mountains of south central and western New Mexico into southeastern Arizona, south into Chihuahua, Mexico.

Material seen. NEW MEXICO. Lincoln County: White Mts., *Wooton 524*, type collection (NY, US) and *Wooton* in 1901 and 1905 (US); West Peak, El Capitan Mts., *Earle & Earle 220* (NY); Mesilla Park, *Tinsley* in 1893, type collection *P. ellipticus* (NY, US); Ruidoso Creek, *Wooton* in 1895 (US). Otero County: head of Rio Fresnal, *Barlow* in 1911 (C); Cloudcroft, Sacramento Mts., *Rehder 372* (US), *Eggleston 14541* (US), *Wooton* in 1899 (US), and *Orcutt 1351* (US). Without definite locality, *Wright 1101*, the plant which Gray called *P. serpyllifolius* var., therefore from "mountain sides at the Copper Mines" (G, NY, US).

When *Wooton* described *P. argyrocalyx* he included therein the Wilcox collection from Arizona. That plant was later made the type of *Rydberg's P. argenteus*. The two entities are similar and undoubtedly they are closely related; in many areas they grade into one another. Yet subsp. *argyrocalyx*, as it occurs in Lincoln County, New Mexico, is very unlike any collections of *Philadelphus* from Arizona, the pubescence of the calyx being much more curled and matted, consisting not only of matted curled trichomes but also of long straight hairs. The leaves are conspicuously hirsute with short erect hairs, a condition which is characteristic of nearly all material from southwestern New Mexico but not of the plants from Arizona. However, material becomes more and more like subsp. *argenteus* near the Arizona border until, in the mountains of extreme southeastern Arizona, the material is intermediate in nature between the two subspecies. The following collections therefore are not quite identical with the type collection and some are at least as similar to subsp. *argenteus* as to subsp. *argyrocalyx*. All have hirsute leaves. NEW MEXICO. Sierra County: Mimbres Mts., Hillsboro Peak, *Diehl 626* (P). Socorro County: San Mateo Peak, *Goldman 1745* (US). Grant County: Burro Mts., *Metcalfe 173* (C, G, NY, P, S, US), quite typical as to leaves, the calyx almost the same as in material

from the type locality, the petals pubescent; Animas Peak, *Goldman* 1370 (US). Valencia County: mountains west of Grants Station, *Wootton* 1109 (US). ARIZONA. Oak Creek, *Goldman* 2174 (US). Pinal County: Superstition Mts., *Harrison* 6604 (NY). Cochise County: Chiricahua Mts., *Price* in 1894 (S) and *Jones* 28327 (C, P), Barfoot Park, *Blumer* 1291 (G, NY, S), very close to *P. argenteus*, but calyx very sparsely hairy, the leaves hirsute, however; White River Canyon, Chiricahua Mts., *Toumey* in 1894 (C); Upper Pine Canyon, *Burrall* in 1906 (US). Pima County: Mt. Lemmon, Santa Catalina Mts., *Livingston & Thorner* in 1906 (NY); Santa Catalina Mts., *Lemmon & Lemmon* 186 (C) and *Lemmon* 170 (G); near Mud Springs, *Harris* C16344 (US). Graham County: Pinaleno Mts., Bonita, *Munz* 1248 (P). MEXICO. CHIHUAHUA: Colonia Juarez, Sierra Madre Mts., *Jones* in 1903 (NY, P, US).

Other collections are more intermediate with subsp. *typicus*: Hillsboro Peak, Sierra County, New Mexico, *Metcalf* 1323 (C, G, NY, P, US). The plants of this collection have silvery leaves and united stamens (characters of subsp. *argyrocalyx* but the calyces, as in subsp. *typicus*, are nearly glabrous.

1e. PHILADELPHUS MICROPHYLLUS Gray subsp. *stramineus* (Rydb.) comb. nov. *P. stramineus* Rydb. N. Am. Fl. 22: 172. 1905.

Much the same as subsp. *occidentalis*, but the calyces usually canescent with stiff straight appressed hairs; leaves mostly 10–25 (probably averaging about 15) mm. long, pubescence of both surfaces usually appressed, if hairs more erect, then all approximately the same length; petals 7–10 mm. long, their outer surfaces sometimes pubescent at base; stamens 30–50 but usually 32, the filaments from scarcely united to united to near the tips.

Type. White Mountains, Mono County, California, *Shockley* in 1888.

Range. Foothills and lower levels of the Charleston Mountains of Nevada, White Mountains of California, and San Pedro Martir Mountains of Lower California. Probably more widespread than present collections indicate.

Although it is believed that subsp. *stramineus* is a valid entity, if it is to be maintained it must be on a different basis than that used by Rydberg. It was keyed by him on the following characters: "Leaf blades equally grayish on both surfaces; sepals acute; bark of the old stems straw colored," whereas *P. microphyllus*, in contrast, had "leaf blades paler beneath; sepals acuminate; bark of the old stems gray." The leaf-blades of the Shockley collection are paler on the lower surfaces than on the upper; the sepals are just as sharp-pointed as are those of much of the material of *P. microphyllus* subsp. *typicus*; lastly, although it is true that the older bark of the type collection of *P. stramineus* is not grayish, in other collections of that entity from the White Mountains (*Cassel*

262), the bark is as weathered and gray as that of any material from New Mexico.

The unique characteristics of the entity are as follows: the calyces of subsp. *stramineus* are grayish with dense stiff straight hairs, in this respect being more similar to subsp. *argenteus* than to either subsp. *occidentalis* or subsp. *typicus*. Usually there are fewer stamens (thirty-two being the commonest number) per flower than in subsp. *argenteus*, subsp. *occidentalis*, or subsp. *typicus*, but since there are occasional plants with as many as forty stamens per flower (*Percy Train 2178*, from the Charleston Mountains), too much importance should not be ascribed to this peculiarity of subsp. *stramineus*.

Material seen. NEVADA. Clark County: Charleston Mts., *Clokey & Clokey 7133* (NY, S, Wash), *Clokey 5458* (NY, S, Wash), *Clokey 5490* (NY, S, Wash), *Heller 10998* (C, NY, S, US), *Clokey 7540* (G), *Percy Train 2178* (NY), *Jones* in 1927 (P), and *Jaeger* in 1925 (P). CALIFORNIA. Inyo County: White Mts., Black Canyon, *Cassel 262* (S) and *Duran 540* (C, NY, P, S, US), Wyman Canyon, *Ferris 6966* (S); Crag Canyon, Grapevine Mts., *Gilman 3262* and *3259* (P). Mono County: White Mts., *Shockley* in 1888 (NY, type) and *Shockley 454*, probably type collection also (C, G, S, US). MEXICO. LOWER CALIFORNIA. San Pedro Martir Mts., Vallecitos, *Goldman 1223* (US); San Pedro Martir, *Brandegee* in 1893 (C) and *Heller* in 1902 (C); La Encantada, *Wiggins & Demaree 4947* (C, G, NY, P, S, US); east of La Encantada, *Melinge* in 1931 (P, S, US). Some of these collections from Lower California approach subsp. *pumilus* in that the upper surfaces of the leaves tend to be hirsute with short erect hairs; further collections may prove that they more properly belong with that entity.

Material from Zion National Park is unique in that the pubescence of the upper surfaces of the leaves is short hirsute rather than strigose. In this respect the plants resemble subsp. *pumilus*, but that entity has long, appressed hairs mingled with the short erect ones, whereas the material from Zion Canyon is hirsute with hairs of uniform length. Also, the leaves of the plants from California are smaller. This variant from Utah is therefore accorded minor status as follows.

If. *PHILADELPHUS MICROPHYLLUS* Gray. subsp. *STRAMINEUS* (Rydb.) C. L. Hitchc. forma *zionensis* forma nov.

Planta a subsp. *stramineus* differens: folia supra pilosula.

This form differs from subsp. *stramineus*, in the leaves which are hirsute above with short semi-erect hairs of uniform length.

Type. Near summit of Lady Mountain, Zion National Park, Washington County, Utah, June 19, 1928, *T. Craig 1439*, Pomona College Herb. no. 184362.

Range. Known only from Zion Canyon, Utah.

Material seen, in addition to the type. Zion Canyon, *Jones* in 1923 and in 1925 (P), *Garrett R2669* (NY), and *Woodbury 19* (US); "Utah," *Ward 699* (US).

1g. *PHILADELPHUS MICROPHYLLUS* subsp. *pumilus* (Rydb.) comb. nov. *P. pumilus* Rydb. N. Am. Fl. 22: 173. 1905.

Much like subsp. *stramineus*, especially as to pubescence of the calyces, but leaves usually averaging no more than 8 mm. long, their upper surfaces hirsute with many short stiff erect hairs mixed with fewer and longer more appressed hairs; petals 6–10 mm. long, usually slightly pubescent on the outer surfaces near base; stamens 32 (to 50), the filaments free or united at base only; styles from completely united to almost entirely free.

Type. Tamarack Valley, San Jacinto Mountains, Riverside County, *Hall 2500*.

Range. Apparently restricted to the San Jacinto and Santa Rosa Mountains of southern California at 7000–8500 feet elevation. Possibly also in Lower California (see under subsp. *stramineus*).

Material seen. CALIFORNIA. Riverside County: Santa Rosa Mts., *Munz 15392* (Wash); San Jacinto Range, *Hall 800* (S); San Jacinto Mts., near Tamarack Valley, *Hall 2500*, type collection (C, NY, S, US); Dark Canyon, *Munz 8762* (P) and *Munz & Johnston 8738* (P); Long Valley to Palm Springs Trail, *Jaeger 1015* (C, P); above Chino Canyon, *Jaeger* in 1922 (S, US).

The variation in the degree of union of the styles is easily seen in this phase of the species. The flowers of the type collection have styles completely united, even the stigmas being united over half their length in a few cases. The collection made by Munz and Johnston is so similar to the type that Rydberg surely would have called them conspecific, yet the styles of this collection are free nearly to the ovary. It is because of such instances that the union or non-union of the styles is considered of secondary importance as a diagnostic character.

1h. *PHILADELPHUS MICROPHYLLUS* Gray subsp. *typicus* nom. nov. *P. microphyllus* Gray, *l.c.*; Rydb. N. Am. Fl. 22: 172. 1905.

Leaves (12) 17–35 mm. long, ovate-lanceolate to lanceolate, strigose on both surfaces to glabrate above, the hairs all appressed but the upper surfaces usually greenish; calyces glabrate to moderately strigose, the tube 2–4 mm. long, usually strigose on the angles, the lobes often glabrous on the outer surfaces, moderately lanate on inner surfaces; petals 11–17 mm. long, not pubescent on the outer surfaces; stamens mostly 40–52 (32), practically free except for few that are geminate.

Type. Eleven miles above Santa Fe, on Santa Fe Creek, New Mexico, June to July, 1847, *Fendler 266*.

Range. Central and northern New Mexico, southern Colorado, and Apache County, Arizona; also from the Chisos Mountains of Texas.

This, the typical form of the species, characterized chiefly by the large flowers and sparse pubescence of the calyx, is the only phase of the species found in northern New Mexico. It inter-

grades with subsp. *occidentalis* on the north and west, and with subsp. *argyrocalyx* on the south. Although most of the flowers of the type collection have about thirty-two stamens, the number of stamens present in the bulk of the material seen is between forty and fifty-two.

Material seen. NEW MEXICO. Rito de las Frijoles, *Cockerell* in 1912 (US). Socorro County: Beartrap Canyon, San Mateo Mts., *Eggleston* 18654 (NY, US); Hop Canyon, Magdalena Mts., *Diehl* 463 (P) and *Herrick* 608 (US), Copper Canyon, Magdalena Mts., *Goldman* 1669, intermediate with subsp. *argyrocalyx* (US). Bernalillo County: Albuquerque, *Jones* in 1884 (P). Valencia County: Grant's Station, *Wooton* in 1892, approaching subsp. *argyrocalyx* (NY). Sandoval County: Balsam Park, Sandia Mts., *Ellis* 107 (NY, US); Sandia Mts., *Herrick* in 1898 (US); Placitas, Sandia Mts., *Wooton* in 1910 (US); Ellis Ranch, Sandia Mts., *Wooton* in 1910 (US); Guadalupe Canyon, San Mateo Mts., *Eggleston* 18736 (US). Santa Fe County: Santa Fe Creek, *Fendler* 266, type collection (G, NY, US); Santa Fe Canyon, *Heller & Heller* 3792 (G, NY, P, S, US) and *Wooton* in 1910 (US); near Santa Fe, *Arsène & Benedict* 15742 (US). San Miguel County: mouth of Indian Creek, *Standley* 4547 (G, NY, US). Taos County: Taos River Canyon, *Nelson* 11471 (C, G); Red Canyon, near Questa, *Hitchcock et al* 4148 (C, P, Wash, WSC). COLORADO. Las Animas County: Brantley Canyon, *Osterhout* 2077 (C, NY, P); Mesa de Maya, 60 miles east of Trinidad, *Rollins* 1835 (NY, WSC). Montrose County: Cimarron, *Nelson & Nelson* 425 (C), with some doubt as no petals present. Fremont County: west of Parksdale, *Jones* in 1913 (S); Royal Gorge, *Bacigalupi* 1009 (NY, P, S), without petals, hence some doubt; Canyon City, *Brandege* 84 (C). UTAH. Grand River near Moab, *Jones* in 1915, intermediate with subsp. *occidentalis* (NY). ARIZONA. Canyon de Chelly, *Nelson* 36, almost surely belongs here but no flowers on plant so identity cannot be certain (US).

Several collections from the Chisos Mountains, Texas, must be placed here, even though they have smaller flowers than those common to the material from New Mexico. At first glance these Texan plants appear to be sufficiently different to be maintained as a separate entity, but it has been found to be impossible to construct a key that will separate them from subsp. *typicus*. Their leaves are quite green when dried, but this condition may be due to the care with which they were preserved; the stamens vary in number from twenty-nine to forty per flower; the flowers are about the size of those of subsp. *occidentalis*, but the leaves and calyces are more nearly glabrous than they are in that plant. It is entirely possible that these plants will prove to be genetically distinct from either subsp. *typicus* or subsp. *occidentalis*, but field study will be necessary in order to detect distinguishing characters, if such there be. TEXAS. Brewster County, Chisos Moun-

tains: Mt. Emory, *Warnock 866* (US), Upper Boot, *Cory 7076* (P) and *Cory 7077* (G); 2 miles southwest of Boot Spring, *Moore & Steyermark 3160* (C, G, NY, S); Lost Mine Peak, *Ferris & Duncan 2856* (NY, S); with no further locality, *Mueller 8013* (NY) and *Havard 40* (G).

11. *PHILADELPHUS MICROPHYLLUS* Gray subsp. *occidentalis* (Nelson) comb. nov. *P. occidentalis* Nelson, Bull. Torrey Bot. Club 25: 374. 1898. *P. minutus* Rydb., N. Am. Fl. 22: 173. 1905; type, Black Canyon of the Gunnison, Colorado, *Baker 266*. *P. nitidus* Nelson, Bot. Gaz. 42: 54. 1906; type, Sapinero, Colorado, *Wheeler 425*. Second cited specimen was *Baker 266*, hence *P. nitidus* is surely the same as *P. minutus*.

Pubescence much the same as in subsp. *typicus*, the leaves often glabrate above, mostly 10–16 (to 25) mm. long, elliptic-lanceolate to lanceolate; petals 9–11 mm. long, not pubescent on outer surfaces; stamens usually about 40 (29–45), united at base only, if at all; styles wholly united or free one-third to one-half their length.

Type. Near Rock Springs, Sweetwater Canyon, Wyoming, July 25, 1897, *Smith 3595*.

Range. Central and northern Colorado, southwestern Wyoming, and eastern Utah.

The subsp. *occidentalis* merges with the subsp. *typicus* and is distinguished from that phase with some difficulty. In general, however, it has smaller flowers and leaves. In the western part of its range it also intergrades with subsp. *stramineus* but can usually be distinguished from that plant because of its greater number of stamens (forty or more as compared with thirty-two) and less pubescent calyces.

There can be little doubt that *P. nitidus* and *P. minutus* are the same entity since Nelson cited three collections of *P. nitidus*, one of which was collected by Baker (no. 266), in Black Canyon, Colorado. This is the same collection which Rydberg, a year previously, had selected as the type of his *P. minutus*. Nelson specified that *P. nitidus* had "styles distinct down to the ovary." Rydberg claimed *P. minutus* had "styles united one-half to two-thirds their length." Although I have seen no flower which I would describe as having styles distinct to the ovary, I am convinced that the degree of union of the styles is not a particularly dependable character. One of the other two collections which Nelson cited under *P. nitidus* (*Jones 6303*), from Belknap, Utah, has the styles united to the stigmas in the flowers I have examined. Thus it seems evident that free or partially free styles are not a constant characteristic of subsp. *occidentalis*. Neither are the styles of subsp. *typicus* always united, for example, in a collection from the Sandia Mountains, New Mexico (*Ellis 107*), they are but incompletely united.

Philadelphus minutus was separated from *P. occidentalis* in

Rydberg's key on the basis that the styles were partially free in the former; thus it can be seen that Rydberg and Nelson both believed their species to be unique and separable from *P. occidentalis* for the same reason. I hesitate, therefore, to reduce *P. minutus* to synonymy but can find no true criterion by which it can be maintained as distinct in any way from *P. occidentalis*. The calyx-tube, according to Rydberg, is 2 mm. long both in *P. occidentalis* and *P. minutus*, whereas it is "4-5 mm. long" in *P. microphyllus*. I do not believe that there is any such difference. Surely Rydberg could not have taken his measurements for the two species from flowers at the same stage of development as it is possible to find flowers of nearly equal size on plants which Rydberg would have called *P. microphyllus*, *P. minutus*, and *P. occidentalis*, respectively.

According to Nelson, *P. occidentalis* has styles "free for from one-third to one-half their length." Rydberg said of it "styles usually wholly and the oblong or clavate stigmas partly united." Both conditions prevail and can be seen in the material here cited.

Material seen. COLORADO. S. Colorado, Palmer (US) and Popenoe in 1876 (US). Garfield County: Glenwood Springs, Palmer 38115 (NY, US). Montrose County: Cimarron, Jones in 1890 (P) and in 1925 (P); Black Canyon of the Gunnison, Baker 266, type collection of *P. minutus* (C, G, NY, P, US); Newcastle, Cary 153 (US). Fremont County: Canyon City, Brandegee in 1877 (C) and Osterhout 2092, very close to subsp. *typicus* and possibly really that form (P); Cotopaxi, Johnston & Hedgecock 740 (NY); Royal Gorge, Clokey 3791 (C, G, NY, P, S, US, WSC) close to subsp. *typicus* but calyx somewhat more pubescent; Oak Creek Canyon, Rollins 1240 (G, NY). WYOMING. Sweetwater County: near Rock Springs, Smith 6919 and Nelson 3595 (G, NY, US). This last collection is from the exact type locality and is the same number as the type but that collection was asserted to have been made by R. A. Smith rather than by Nelson. UTAH. Daggett County: 12 miles south of Manila, Hitchcock et al 3912a (C, P, S, WSC). Carbon County: Cottonwood Canyon, Graham 9520 (G). Beaver County: Beaver City, Palmer 151 (G, NY); S. Utah, Palmer 151 (US). Grand County: Thompson's Springs, Jones in 1913 (G, P, US, WSC); Grand Canyon, Graham 9916 (G).

The following collections are also being referred to subsp. *occidentalis*, although they intergrade, in greater or lesser degree, with subsp. *typicus*. UTAH. Grand County: Moab, Jones in 1913 (C, G, NY, S, US) and in 1891 (P), these plants are peculiar in that they have large thick leaves that are semi-glabrous on the upper surfaces; near Wilson Mesa, Rydberg & Garrett 8380 (NY). Summit County: Brush Creek Canyon, Uintah Mts., Goodding 1274 (G, NY, US); Brush Creek Gorge, Graham 10015 (US). Uintah County: Ashley Creek, near mouth of Dry Fork, Graham

6270 (US); 10 miles northwest of Vernal, *Graham* 7454 (G). San Juan County: Abajo Mts., *Rydberg & Garrett* 9608 and 9609 (NY, US); La Sal Mts., *Purpus* 6611 (C, P, US), near Clarke Lake, *Maguire et al* 5803 (C), road to Warner Ranger Station, *Maguire et al* 5802 (C, US); locality uncertain, "marvine laccolite" only data on label, hence probably also from the La Sal Mts., *Jones* 5663v (C, NY, P, US). ARIZONA. North end Carrizo Mts., *Standley* 7323 (US, with some doubt, as flowers lacking). Apache County: Luka-Chukai Mts., *Goodman & Payson* 2843 (NY, Wash.).

In the southwestern part of Utah and in northwestern Arizona subsp. *occidentalis* merges with subsp. *stramineus*. The following collections are intermediate between those two phases of the species. Most of them have the pubescence characteristic of subsp. *stramineus* but the stamen complement is more suggestive of subsp. *occidentalis*, in some few cases there are as few as thirty-two stamens but most flowers have about forty, fifty-two being the largest number seen.

UTAH. Sevier County: Belknap, *Stokes* in 1900 (NY, S) and *Jones* 6303 (NY, P, S. US); Burrville Canyon, *Jones* 5633 (C, NY, P, US). Piute County: Marysvale, *Jones* 5375p and 7405j (P, US); Bullion Creek, near Marysvale, *Jones* 5904d (NY, P). ARIZONA. Coconino County: Cape Royal, north rim Grand Canyon, *Peirson* in 1927 (P); Grand View Trail to bottom of Grand Canyon, *Ferris & Duncan* 2257 (S); Grand Canyon, *Toumey* (S), *Toumey* 133 (US), *Hitchcock* 91 (US), and *Knowlton* 258 (US); Navaho Reservation, *Vorhies* 109 (C, G, NY).

2. PHILADELPHUS MEARNsii Evans ex Rydb. N. Am. Fl. 22: 174. 1905.

A low rounded shrub probably not much over 1 m. tall, the branches rigid, more or less spinescent, bark of young stems brownish, strigose, quickly exfoliating, the old branches dark gray; leaves elliptic or lanceolate, 6–25 mm. long, pubescence of very coarse hairs almost equally grayish-strigose on both surfaces, petioles 1–3 mm. long; flowers mostly single at the ends of very short leafy stems, the hypanthium grayish-strigose, 1.5–2.5 mm. long in flower, 3 mm. long in fruit, sepals *ca.* 3 mm. long, acuminate, strigose on outer surface, lanate within; petals whitish or ochroleucous, oblong-lanceolate, 7–11 mm. long, ovate-lanceolate to lanceolate, acute or sharply 2-toothed at apex; stamens 16–20 (24), the filaments short, free; styles less than 1 mm. long, united to top, stigmas 1.5–2 mm. long, almost completely united.

KEY TO SUBSPECIES OF *P. MEARNsii*

- | | |
|---|---|
| Petals 8–10 mm. long; leaves mostly less than 15 mm. long, strigose on both surfaces with appressed pubescence; petioles 1–2 mm. long | 2a. <i>P. Mearnsii</i>
subsp. <i>typicus</i> |
| Petals 10–11 mm. long; leaves mostly over 15 mm. long, the upper surfaces with erect hairs; petioles 2–3 mm. long | 2b. <i>P. Mearnsii</i>
subsp. <i>bifidus</i> |

2a. *PHILADELPHUS MEARNsii* subsp. *typicus* nom. nov. *P. Mearnsii* Evans ex Rydb., *l.c.*

Characters as in key, the leaves rather thick, the pubescence of very coarse short hairs.

Type collection. Upper Corner Monument, Grant County, New Mexico, April 28, 1892, *Mearns 36* (G, NY, S, US).

Other material seen. NEW MEXICO. Eddy County: Guadalupe Mts., near Three Forks of Rocky Arroyo, May 6, 1932, *Wilkens 1833* (US); Carlsbad Cave, *Bailey* in 1924 (US). TEXAS. Culberson County: Guadalupe Mts., above McKittrick Canyon, July 17, 1931, *Moore & Steyermark 3477* (C, G).

Because of the uniform strigose pubescence, short styles and few stamens, this entity is readily distinguished from the other species and even though it is known only through three collections, there can be no doubt of its validity. The Moore and Steyermark collection is in fruit and therefore lacks flowers, but the coarse hairs and short styles make it seem certain that it belongs here.

Although the species was described as having "about 15" stamens, those flowers of the type collection which I have examined have sixteen. The Wilkens collection also has sixteen stamens, a fact which helps to convince one that it is conspecific with the Mearns collection. However, Bailey's collection from Carlsbad has flowers with twenty-four stamens. A comparison of the Bailey and Wilkens collections cannot but convince one that they are not only conspecific but that they are too similar to be separated nomenclaturally, hence the species must be considered to have as few as sixteen (occasionally fifteen?) and as many as twenty-four stamens.

2b. *PHILADELPHUS MEARNsii* subsp. *bifidus* subsp. nov.

Planta *P. Mearnsii* subsp. *typicus* similis, hoc modo differens: foliis longioribus gracilioribusque, laminis ad 30 mm. longis, supra hirsuto-hispidis, pilis erectis; petiolis 2-3 mm. longis, petalis 10-11 mm. longis, apices 2-dentibus; staminibus 24, filamentis non connatis.

Leaves longer and more slender than in subsp. *typicus*, the blades as much as 30 mm. long, pubescence of their upper surfaces hirsute-hispid, the hairs slender, scarcely at all appressed, petioles 2-3 mm. long; petals 10-11 mm. long, the apices distinctly sharply 2-toothed; stamens 24 (probably some variation), the filaments free.

Type. Sierra Madre, near Monterrey, Nuevo Leon, Mexico, May 2, 1906, *Pringle 13879* (G).

Known only from the type collections at Gray Herbarium and United States National Museum, one branch of the latter specimen with partially double flowers. Superficially this collection seems to bear little resemblance to the type of *P. Mearnsii*. However, it is evident that that collection was an extremely small-

flowered plant and that probably the other collections cited (*Wilkens 1833*) are more truly representative of the entity. Since the plant of the Wilkens collection is larger-leaved and larger-flowered, it is more suggestive of Pringle's plant from near Monterrey. Because there is so much similarity between the flowers of the two entities, the plant from Mexico is being accorded subspecific rank. Toothed, oblong petals, few stamens, short styles, and united stigmas comprise an unusual combination of characters and their presence in both these entities makes it seem logical to assume that there is close relationship between the two, a relationship that is too close to be brought out by according both of them specific status.

3. *PHILADELPHUS SERPYLLIFOLIUS* Gray, Pl. Wright. 1: 77. 1850.

A low rounded, rather rigid shrub 1-2 m. tall, young branches brownish, densely strigose-pubescent, bark of older stems exfoliating, the old stems grayish; leaves entire, ovate-lanceolate, 6-30 (averaging about 15) mm. long, 3-12 mm. broad, 3-nerved from base, the upper surfaces greenish and often shining, from sparsely strigose to rather densely strigose and short hirsute, lower surfaces grayish, the pubescence rather dense, of long straight appressed hairs and close covering of tangled tomentum, distinctly petiolate, the petioles 1-3 mm. long; flowers commonly 1 or 3 (or 2) at the ends of short leafy shoots, the pedicels 1 or 2 mm. long; calyx usually silvery with long appressed and shorter more or less curled hairs, but sometimes the indumentum more sparse and calyx greenish, the tube 2-3 mm. long in flower, 3-4 mm. long in fruit, the lobes lanceolate, acuminate, 4-5 mm. long, densely lanate on inner surfaces; petals apparently cream colored, 6-8 mm. long, more or less oval and usually somewhat emarginate or erose; stamens usually 28 (few more or less), the filaments free; styles less than 1 mm. in length, united, the stigmas 1.5-2 mm. long, almost completely united.

Type. "Between western Texas and El Paso, New Mexico," in 1851, *C. Wright*. Very closely matched by a specimen collected near Fort Davis, Texas, *Palmer 34474*.

Material seen. NEW MEXICO. Without definite locality, 1851-52, *C. Wright 1100* (G, NY); Mexican Boundary Survey (NY), probably the same as the first. TEXAS. Head of Seco, *Reverchon 54* (G), one branch of this collection has leaves only 12 mm. long whereas a younger more vigorous shoot has leaves that are 30 mm. long. Jeff Davis County: deep canyon off Limpia Canyon, near Fort Davis. *Palmer 34474* (NY, US). Edwards County: limestone bluffs, Upper Cedar Creek, *Palmer 12333* (C). Kendall County: Spring Creek, near Boerne, *Palmer 11492* (C) and *Palmer 11595, 12900* (C, P); Cibola Canyon, Boerne, *Pennell 10418* (NY), pubescence of leaves strigose above; Musquez Canyon, W. Texas, *Havard 41* (G). Culberson County: McKittrick Canyon, Guadalupe Mts., *Moore & Steyermark 3479* (C, G, NY, S).

Philadelphus serpyllifolius is, of course, closely related to *P. microphyllus* but differs strikingly because of the tomentum of the leaves and the extremely short styles. The collections from Kendall County are much less pubescent than is the rest of the material.

4. *PHILADELPHUS PURPUSII* Brandege, Univ. Calif. Publ. Bot. 4: 270. 1912.

A low spreading shrub 1–2 m. tall; young branches brownish, densely strigose-pubescent, older bark grayish, winter buds quite obviously not enclosed in the leaf bases, petioles 1–4 mm. long, blades entire, ovate-lanceolate to lanceolate, usually slightly mucronate, 20–35 mm. long, 3-nerved, pubescence of both surfaces grayish-green, almost equally strigose with short thick hairs; flowers single at the ends of short branches, the pedicels 3–6 mm. long; calyces grayish-strigose, the tube 3–4 mm. long, the lobes 4–6 mm. long, acute; petals obovate to oval, 10–15 mm. long, rounded, scarcely emarginate; stamens 40–50, filaments distinct; styles 2–3 mm. long, united about one-half to four-fifths their length, basal portion and surrounding ovary grayish pilose; stigmas free, 2–3 mm. long.

Type. Minas de San Rafael, San Luis Potosi, Mexico, *Purpus* 5368.

Known only from two collections from the type locality, *Purpus* 5368 (C, G, NY) and *Purpus* 4910 (G, US).

Philadelphus Purpusii is most easily distinguished because of the pilosity of the styles and upper ovary, but the grayish-green strigose leaves, large petals, and exposed buds are all features that help to make it the distinctive species that it is.

University of Washington, Seattle,
March, 1942.

A NEW SPECIES OF PHACELIA FROM SALINE VALLEY, CALIFORNIA

LINCOLN CONSTANCE

Phacelia amabilis sp. nov. Herba annua vel biennis, omnino glanduloso-puberula et hispida praecipue in calycibus inflorescentibusque, circa 1 m. alta; caulis crassus ramosus; folia petiolata oblonga oblongo-ovatave, 8–15 cm. longa, 3–5 cm. lata, pinnatifida, lobis oblongis dentatis, summa reducta minus alte divisa; inflorescentia corymbosa, cymis 5–12 cm. longis in fructu erectis; pedicelli in fructu 2–3 mm. longi; calycis lobae anguste lanceolatae, 3–5 mm. longae, 1–2 mm. latae, corolla plus quam dimidio breviores, capsulam leviter excedentes; corolla late campanulata, 7–8 mm. longa, 8–12 mm. lata, alba, lobis integris; appendiculae supra tubae basin minus quam 1 mm. insertae, parte libera lata; stamina exserta; stylus exsertus, pallido-lilacinus;

capsula ovoidea, 3-4 mm. lata; semina plerumque 2 vel 4, 3-4 mm. longa, tenuissima pallidissima, non corrugata, superfacie ventrali jugo saliente utrinque excavata.

Annual or biennial, about 1 m. high; stem stout, branching; herbage glandular-puberulent throughout and hispid, especially on the calyces and in the inflorescence; leaves petiolate, oblong to oblong-ovate, 8-15 cm. long, 3-5 cm. broad, pinnatifid, the lobes oblong, dentate, the uppermost leaves reduced and less deeply divided; inflorescence corymbose, the cymes 5-12 cm. long and erect in fruit; pedicels 2-3 mm. long in fruit; calyx lobes narrow lanceolate, 3-5 mm. long, 1-2 mm. broad, less than one-half as long as the corolla, slightly exceeding the capsule; corolla broadly campanulate, 7-8 mm. long, 8-12 mm. broad, white, the lobes entire; appendages attached a little less than 1 mm. above the base of the tube, the free portion broad; stamens and style exserted 5 mm. or more, the latter pale lavender; capsule ovoid, 3-4 mm. long, 2-3 mm. broad; seeds usually 2 or 4, 3-4 mm. long, very thin and pale, not corrugated, the ventral surface excavated on each side of a salient ridge.

Type. "In full bloom along creek, Hunter Creek, altitude 1800 feet, Saline Valley, Inyo County, California," April 21, 1942, *Annie M. Alexander* and *Louise Kellogg* 2681 (Herbarium of the University of California no. 671871). *Phacelia amabilis* was first thought to be an albino form of *P. crenulata* with which it was growing.

In his excellent, "Revision of the *Phacelia crenulata* group for North America" (Bull. Torrey Bot. Club 64: 81-96, 133-144. 1937), Voss has provided the most complete modern treatment yet available for any portion of this interesting and "difficult" genus. Although interspecific differences are small in this group, most of the entities accorded specific rank by him appear to be rather sharply distinguished from one another. The present species, by possession of a broadly campanulate corolla, exserted stamens and ventrally excavated but uncorrugated seeds would appear to be most closely related to *P. congesta* Hook., of Texas, New Mexico, southeastern Arizona and northern Mexico. Besides the wide discontinuity in geographical range, *P. amabilis* differs from *P. congesta*—as indicated on the accompanying plate—in its shorter calyx, larger and differently proportioned corolla, more exserted stamens and style, and its larger, paler, thinner and more broadly margined seeds.

For the past several years, the Misses Alexander and Kellogg have collected extensively in the relatively inaccessible desert mountains of the southwestern United States. The Herbarium of the University of California has been enriched by receiving their nearly 3500 numbers, as well as many valuable duplicates, which have been distributed to other leading herbaria.

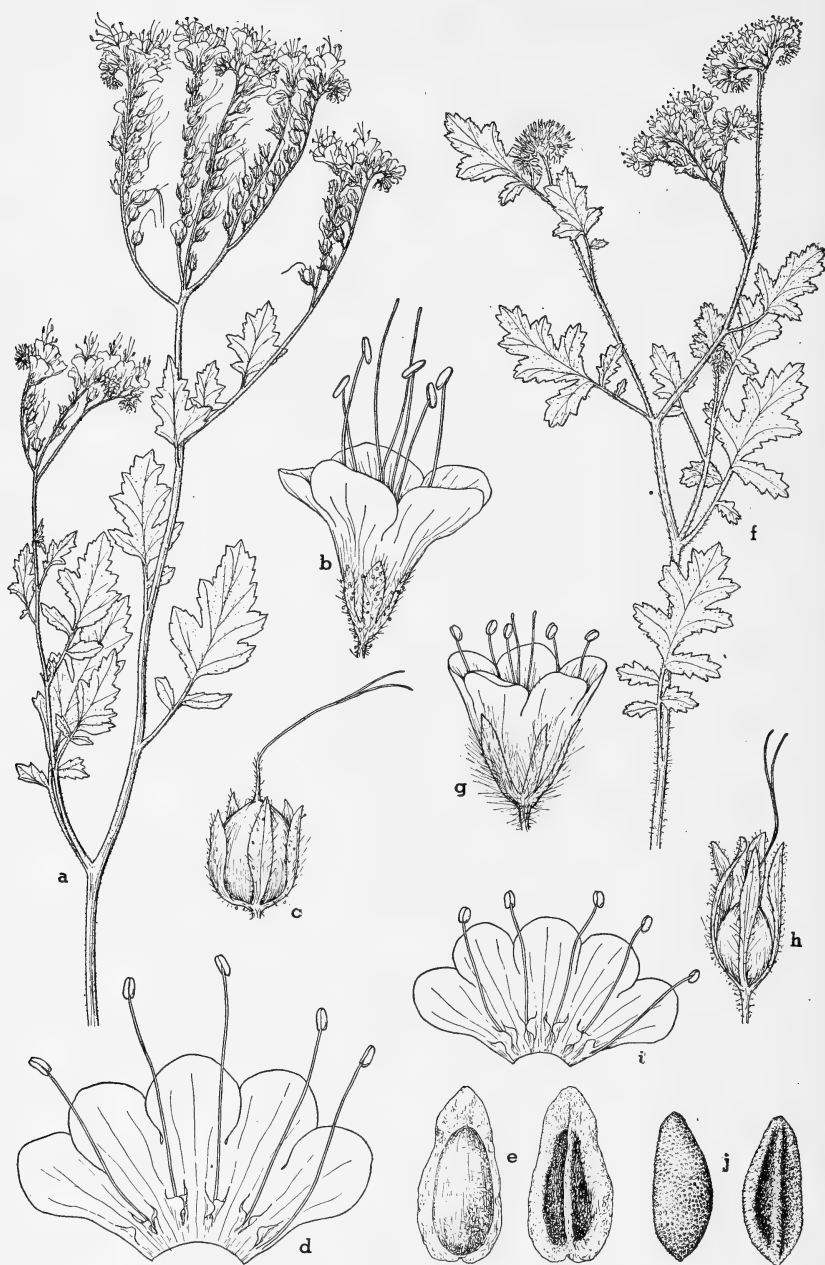


PLATE 3. PHACELIA. Figs. a-e, *P. amabilis*: a, habit; b, flower; c, fruiting calyx and capsule; d, expanded corolla; e, seeds. Figs. f-j, *P. congesta* var. *rupestris*: f, habit; g, flower; h, fruiting calyx and capsule; i, expanded corolla; j, seeds. (Habit drawings $\times \frac{1}{2}$; flowers and capsules, $\times 3$; seeds, $\times 7$.)

Phacelia amabilis is but one of the rare or seldom-collected species which has been secured as a result of their indefatigable efforts.

The writer would ordinarily have preferred to delay publication of this species until more material is available, but in view of the curtailment of field work in the foreseeable future, it seemed advisable to describe it at this time.

Department of Botany,
University of California, Berkeley,
November, 1942.

GILIA MULTIFLORA NUTT. AND ITS NEAREST RELATIVES

THOMAS H. KEARNEY AND ROBERT H. PEEBLES

Gilia multiflora Nutt., a widely distributed species of New Mexico and Arizona, is extremely variable, but is distinguished from its nearest relatives by having the corolla tube nearly always two to three times the length of the lobes, and rarely less than one and a half times the length of the calyx. Very similar to *G. multiflora* in habit, foliage, and pubescence is *G. polyantha* Rydb. which differs, however, in having a shorter corolla tube, this approximately equal in length to the lobes and the calyx.

Typical *G. polyantha* is known apparently only from southwestern Colorado. *Gilia brachysiphon* Woot. and Standl., of southwestern New Mexico, would seem to be specifically distinct from *G. polyantha* were it not for the occurrence in north-central Arizona of a form that is intermediate in several characters. For this reason, it seems best to treat *G. brachysiphon* and the hitherto undescribed Arizona plant as varieties of *G. polyantha*. So far as present information goes, the three forms of this species are rather widely separated geographically.

Another more distantly related member of this small group of perennial plants with filaments normally conspicuously exserted and declined is *G. Harvardi* A. Gray, an apparently rare species of southwestern Texas. The corolla is more pronouncedly zygomorphic, especially in respect to the closely grouped and parallel-declined stamens, than in *G. multiflora* and *G. polyantha*, and for this reason Brand (in Engler, Pflanzenr. 4²⁵⁰: 172. 1907) restored this species to the genus *Loeselia*, where it was placed originally by Asa Gray. *Gilia multiflora* and *G. polyantha*, however, also show a tendency to zygomorphy and the writers concur in Gray's final conclusion that *G. Harvardi* and *G. multiflora* are congeners.

Gilia Macombii Torr., although evidently related to *G. multiflora*, is not considered here because the stamens are not exserted from the corolla tube, or project only about the length of the anthers.

KEY TO THE SPECIES AND VARIETIES.

- Inflorescences short, not thyrsoïd, the zygomorphic flowers in loose, few-flowered terminal clusters; herbage eglandular, villous, even in the inflorescence, with long soft white hairs; stems numerous from a branched caudex, short; corolla tube 6 to 9 mm. long, about twice as long as the calyx, not or only slightly longer than the lobes. 1. *G. Havardi*
- Inflorescences elongate, thyrsoïd-glomerate, the flowers nearly regular; herbage usually more or less glandular in the inflorescence, the long white hairs mostly confined to the lower part of the plant.
Corolla tube 10 to 15 (rarely only 7) mm. long, 1.6 to 2.7 (rarely only 1.2) times as long as the calyx and 1.5 to 3.2 times as long as the corolla lobes, the lobes prevaillingly oblong or narrowly elliptic but occasionally slightly obovate; inflorescences normally contracted and short-branched; pubescence various 2. *G. multiflora*
- Corolla tube 4.5 to 6.5 mm. long, shorter than to 1.2 (exceptionally 1.7) times as long as the calyx and shorter than to 1.5 times as long as the corolla lobes.
Lobes of the whitish, sometimes purple-dotted, corolla 3 mm. wide, oval or broadly elliptic; inflorescences relatively open and long-branched, copiously puberulent with glandular hairs, these intermixed with short white hairs. 3. *G. polyantha* (typical)
- Lobes of the pale violet corolla 1.5 to 2.7 (exceptionally 3.5) mm. wide.
Inflorescences relatively contracted and short-branched, the glomerules dense; upper part of the plant canescent with short white hairs, the glandular hairs relatively few and mostly hidden by the others; corolla lobes prevaillingly elliptic or oblong 3a. *G. polyantha* var. *brachysiphon*
- Inflorescences relatively expanded and long-branched, the glomerules relatively loose; upper part of the plant commonly with abundant glandular hairs, these intermixed with but usually not concealed by the short white hairs; corolla lobes prevaillingly oblanceolate or obovate 3b. *G. polyantha* var. *Whitingi*
1. *GILIA HAVARDI* A. Gray, Syn. Fl. N. Amer. ed. 2, 2¹: 411. 1886. *Loeselia Havardi* A. Gray, Proc. Amer. Acad. Arts and Sci. 19: 87. 1883.

Presidio and Brewster counties, southwestern Texas, near Presidio (*Havard* in 1881, the type collection), vicinity of the Chinati Mountains (*Nealley* in 1889), vicinity of the Chisos Mountains (*Sperry* 623). The stems are less than 20 cm. long. The species is very distinct in appearance from other members of this group. The herbage is uniformly villous with long, soft, white, segmented hairs, these extending even to the calyx, whereas in

G. multiflora and *G. polyantha* such hairs are confined largely to the lower leaves. The leaves are mostly pinnatifid with 3 to 5 lobes. The ovules are "several in each cell" (Gray, *ibid.*).

2. *GILIA MULTIFLORA* Nutt., Jour. Acad. Nat. Sci. Phila. ser. 2, 1: 154. 1848.

This species seems to be known only from the mountains of New Mexico and Arizona, where it is common and widely distributed, but it probably occurs also in northern Mexico. The type, collected by Gambel on "sandy hills along the border of the Rio del Norte, New Mexico," has not been seen by the writers. There is no type material in the herbarium of the Philadelphia Academy of Sciences or in the Gray Herbarium. This is a highly variable species, but departures from the norm in floral characters do not appear, as a rule, to be correlated among themselves or with peculiar vegetative characters. The plants are potentially long-lived and some of the specimens from southern Arizona are distinctly woody toward base. The pubescence consists of two main types of hairs: (1) soft, white, flattened, segmented hairs, these often elongate near the base of the plant, especially on the leaves, but normally becoming very short in the inflorescence, where they are usually intermixed with (2) clavate or stipitate glandular hairs. Occasional specimens show granular puberulence, apparently of a resinous nature. The leaves vary from entire to pinnatifid with 3 to 7 narrow lobes.

The inflorescences are normally contracted and short-branched, but occasional specimens resemble *G. polyantha* Rydb. in their relatively open and long-branched inflorescences. The insertion of the filaments is normally very nearly at the same level, usually just below the rim of the throat, but sometimes deep in the tube. The anthers are at nearly the same level, or some of them are 1 to 2 mm. below the others. Counts in eight ovaries, each from a different individual plant, showed a range from 5 to 15 ovules, indicating a variation of from 2 to 5 per cell.

Two outstanding variants, both found in Arizona, may prove worthy of recognition as varieties when more material is available. The first, collected near Flagstaff (*Rusby* 729), and on "Ivy Mesa, Mogollon Mountains"¹ (*MacDougal* 644), is characterized by numerous, slender, almost flexuous stems; inflorescences with subfarinose puberulence, obscurely if at all glandular or granular; leaves nearly all entire except near the base of the plant, very sparsely villous; corolla tube only 7 to 8.5 mm. long and only 1.6 to 2.0 times as long as the lobes, whereas in *G. multiflora* the tube is usually at least 10 mm. long and more than twice as long as the lobes.

The second remarkable variant was collected in Oak Creek Canyon, Coconino County (*Whiting* 1053/5300). It is distin-

¹ The "Mogollon Mountains" of Arizona are the precipitous southern edge of the Mogollon Mesa, also often referred to as the "Tonto Rim" or "Mogollon Rim."

guished from all forms of *G. polyantha* by having a corolla with tube 2.5 times as long as the lobes, but differs markedly from typical *G. multiflora* in the following characters: calyx 8.5 mm. long and nearly equalling the tube of the corolla, whereas in *G. multiflora* the calyx is normally only 5 to 7 mm. long and seldom more than three-fifths as long as the tube; corolla lobes broadly obovate, three-fourths as wide as long, whereas in *G. multiflora* they are commonly oblong or only slightly obovate and not more than half as wide as long; corolla throat exceptionally ample, 3.5 mm. wide at the orifice in the pressed specimen, as compared with a usual width of 2 to 3 mm. in *G. multiflora*. A collection in the Baboquivari Mountains, Arizona, (*Gilman B124*) has an equally wide corolla throat but is otherwise normal in its flower characters, and the plant is decidedly woody toward base, which is not the case in Whiting's plant.

3. *GILIA POLYANTHA* Rydb., Bull. Torr. Bot. Club 31: 634. 1904. *Gilia exserta* A. Nelson, Bot. Gaz. 40: 65. 1905. *Gilia multiflora* var. *polyantha* Brand, in Engler, Pflanzenr. 4²⁵⁰: 113. 1907.

The type of *G. polyantha*, which is also the type of *G. exserta*, was collected at Pagosa Springs, Archuleta County, southern Colorado, altitude 7,000 feet (*C. F. Baker 538*) and the typical form of the species seems to be known only from this locality, where it has been collected also by Bethel, Willey, and Clokey (*4251*). It is taller and has more elongate, longer-branched inflorescences than most specimens of *G. multiflora* and is readily distinguished from that species by the flower characters stated in the key. On the other hand, it resembles *G. multiflora* in habit, foliage, and pubescence. The leaves sometimes have as many as 9 lobes. Counts of the number of ovules per ovary gave 13 for the type specimen and 10 for the other. A. Nelson (*ibid.*) reported the ovules as only "about 2 in each cell," in the type collection. The plant was stated by Nelson to be biennial, but it is almost certainly perennial, as Rydberg described it.

3a. *GILIA POLYANTHA* Rydb. var. *brachysiphon* (Woot. and Standl.) comb. nov. *Gilia brachysiphon* Woot. and Standl., Contrib. U. S. Nat. Herb. 16: 160. 1913.

The type of *Gilia brachysiphon* was collected in the Organ Mountains, Dona Ana County, New Mexico (*Wooton* in 1894) and this variety is known also from several other localities, all in southwestern New Mexico (Sierra, Grant, and Catron counties). It differs from typical *G. polyantha*, and from most specimens of the following variety, in the rarity or entire absence of glandular hairs. Counts showed 18 ovules per ovary in the type and 14 in another specimen.

3b. *GILIA POLYANTHA* Rydb. var. *Whitingi* var. nov.

A forma typica *G. polyanthae* corolla violacea lobis plerumque obovatis differt; a *G. polyantha* var. *brachysiphon* inflorescentia laxiore et plerumque copiose glandulifera differt; a *G. multiflora*

corollae tubo quam calyce et corollae lobis vix longiore distinguatur.

The type was collected at the Grand Canyon, Coconino County, Arizona (*Whiting 1072/5200*, U. S. Nat. Herb. 1814983). Other collections, all in Coconino County, at elevations of 6,800 to 7,200 feet are: Grand Canyon (*Eggleston 15669, 15682*), south rim of the Grand Canyon (*Collom 1073*), Grand Canyon Road (*Whiting 1047/4311*), near the Grand Canyon (*Lemmon* in 1884),² Williams (*Rusby* in 1883), base of the San Francisco Peaks (*Wooton 489*), Walnut Canyon National Monument (*Beaubien 1054/5320*). There is also, in the United States National Herbarium, an imperfect specimen, labeled in G. R. Vasey's handwriting, "Nevada, Lt. Wheeler, 1872," that apparently belongs here. This specimen may have been the basis for the inclusion of Nevada in the range of *G. multiflora*, in Tidestrom's Flora of Utah and Nevada (Contrib. U. S. Nat. Herb. 25: 435. 1925). If it is correctly labeled as to locality, var. *Whitingi* has a wider range than the other forms of *G. polyantha*.

There is a much stronger tendency than in *G. multiflora*, and in the other forms of *G. polyantha*, to have the corolla lobes widest near the apex, but this is not invariably the case. The stamens, as is usually also the case in *G. multiflora*, are inserted very nearly at the same level. Counts made on six individual plants, including the type, showed that the number of ovules per ovary varies from 6 to 18.

Bureau of Plant Industry,
United States Department of Agriculture,
Washington, D. C.
United States Field Station
Sacaton, Arizona.
June 27, 1942

REVIEW

Wild Violets of North America. By VIOLA BRAINERD BAIRD. Pp. xv + 225, with 17 illustrations in the text and 80 plates in full color. University of California Press, Berkeley. 1942. \$10.00.

This attractive volume, written in non-technical language, will please both professional botanists and amateurs. The preparation of a complete account of North American violets is a task for which the author is especially well equipped. Familiar with the group since childhood, Mrs. Baird assisted her father, Ezra Brainerd, in his well-known studies on the genus and during later years she has continuously added to her knowledge by field and garden studies of almost every species.

The brief preamble contains an informative résumé of the distribution and probable sources of the North American species of *Viola*, a discussion of the variation in such characters as leaf

² Cited by Brand (Pflanzenr.) under *G. multiflora* var. *polyantha*. The collection at Cosnino, Ariz. (*Jones 4043*) also cited by Brand under var. *polyantha*, is *G. multiflora*.

shape and flower color, and a simple explanation of the flower structure and function. There follows a key to the species groups which is both technically accurate and easily understood and utilized by the layman. Especially valuable as a scientific contribution are the two pages of line drawings illustrating the variation in the shape of the pistil, the remarkable and almost ludicrous development of which will interest and perhaps even amuse every reader. Since all were drawn from fresh material, persistent misconceptions as to pistil shape in certain species are here for the first time corrected.

The classification divides the group into three sections, each of which is introduced by a brief discussion of the characters common to its members. The account of each species is very readable and contains information as to the outstanding characters, distribution, habitat and flowering period of each, supplemented by notes on any features of unusual interest such as the derivation of the name, by whom and where the species was first collected, and mention of the characters by which it may be distinguished from its nearest relatives. As is fitting in a treatment which is both popular and technical, Mrs. Baird has not hesitated to group under their respective linneons minor entities which have been named as species. Thus the specific units as she conceives them are readily recognizable even by those without previous experience with taxonomic concepts.

The plates, reproduced from water colors by the late F. Schuyler Matthews, are all natural size and indicate with an unusual degree of accuracy the different shades in the flower color throughout the North American representatives of the genus. The color of practically every species was matched with great care with living material from native colonies or garden transplants and has been faithfully reproduced.

Following the general text, in a "Key to Colors in Wild Violets," the species are grouped according to their principal color tones and these groups are still further subdivided as to the precise shade of flower color. Next, a list of the species is included with citations to the original descriptions and data as to the sources of the material used as a basis for the color plates. The volume closes with indices to the scientific and popular names.

The book is handsomely bound in violet blue cloth with gold lettering and expertly printed in twelve point Baskerville on a highly lustrous coated paper. The edition is limited to one thousand signed copies.—ETHEL CRUM.

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A NEW SPECIES OF TAUSCHIA FROM THE STATE OF WASHINGTON

MILDRED E. MATHIAS AND LINCOLN CONSTANCE

Tauschia Hooveri sp. nov. Herba acaulescens, pseudoscapo e tubere globose, 10–14 cm. alta, omnino glabra glauca; folia in ambitu ovato-triangularia, petiolo excluso, 3–5 cm. longa, 1–6 cm. lata, pinnata vel partim bipinnata; foliola linearia, acuminata, 15–35 mm. longa, 1–2 mm. lata, integra, callosa-apiculata, marginibus reflexis; petioli 2–3 cm. longi; pedunculi graciles, 2–4 cm. longi; calycis dentes obsoleti; corollae albae; antherae purpureae; styli breves, filiformes, recurvati; carpophorum ad medium bifidum, ramis ad apicem approximatis; fructus linear-oblongus ad apicem versus leviter attenuatus, 5–7 mm. longus, circa 2 mm. latus, glaucus, costis evidentibus filiformibus; vittae parvae solitariae in valleculis, 2 in commissura; semini facies fere plana.

Acaulescent with a pseudoscape 10–14 cm. high arising from a globose tuber; glabrous and glaucous throughout; leaves ovate-deltoid in general outline, excluding the petiole 3–5 cm. long, 4–6 cm. broad, pinnate to partially bipinnate, the leaflets linear, acuminate, 1.5–3.5 cm. long, 0.1–0.2 cm. broad, entire, callous-tipped, the margins reflexed; petioles 2–3 cm. long; peduncles slender, 2–4 cm. long; involucre and involucre wanting; fertile rays 3–7, stout, unequal, 2–10 mm. long; pedicels 1–3 mm. long; calyx teeth obsolete; flowers white, the anthers purple; styles short, filiform, recurved; carpophore 2-cleft about one-half way to the base, the halves approximate to the tip; fruit linear-oblong, tapering slightly at apex, 5–7 mm. long, about 2 mm. broad, glaucous, the ribs filiform but evident; oil tubes small, usually solitary in the intervals, 2 on the commissure; seed face nearly plane.

Type. "Near Cowiche, Yakima County, Washington," April 20, 1942, *Robert F. Hoover 5689* (University of California Herbarium no. 671873). There is one other collection, "Hills south of White Swan, Yakima County," March 24, 1942, *Hoover 5616* (Univ. Calif. Herb.). In a letter from the collector dated November 5, 1942, the following additional information is given: "In answer to your question about the habitat of *Tauschia Hooveri*, it grows in 'scablands,' in rather barren rocky clay, with *Artemisia rigida*, *Sisyrinchium Douglasii*, *Eriogonum thymoides*, *Viola trinervata*, etc."

To the best of our knowledge, this species has never been collected before, although the Yakima area has been rather intensively botanized previously by various collectors. It undoubtedly escaped notice because the plants were in ripe fruit

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FIG. 1. *Tauschia Hooveri*: a, in anthesis, $\times 1$; b, in fruit, $\times 1$; c, side view of fruit, $\times 5$; d, cross section of fruit, $\times 10$.

before the end of April, and because in anthesis they so greatly simulate certain of the "bulbous" species of both *Lomatium* and the two species of *Orogenia*.

In a recent series of nomenclatorial transfers, the authors (Bull. Torrey Bot. Club 68: 121-124. 1941) proposed to reduce the monotypic genus *Hesperogenia* Coulter and Rose under *Tauschia* Schlecht. This step was not taken without some misgiving inasmuch as *Hesperogenia* is known only from Mount Rainier, Washington, and the geographically nearest undoubted *Tauschia* is not known to occur north of southwestern Oregon. In addition, the suborbicular fruit of *Hesperogenia* is unique in

Tauschia, although its other characters fit the latter genus very well. The discovery of *Tauschia Hooveri*, however, ends the supposed geographical isolation of *Hesperogenia* and appears to confirm the desirability of including it under *Tauschia*.

We are glad to have the opportunity to name this remarkable species for Dr. Hoover, whose critical collections and keen observations have been invaluable to us in our work with the Umbelliferae.

Department of Botany,
University of California, Berkeley,
November, 1942.

NOTES ON THE FLORA OF THE CHARLESTON MOUNTAINS, CLARK COUNTY, NEVADA V. CACTACEAE

IRA W. CLOKEY

This treatment of the Cactaceae continues a series devoted to a study of the flora of the Charleston Mountains in southern Nevada and published as follows: Madroño 4: 128-130. 1937; Bull. So. Calif. Acad. Sci. 37: 1-11. 1938; *l.c.* 38: 1-7. 1939; and Madroño 6: 211-222. 1942. I wish to express my thanks to Dr. L. Benson, Dr. E. U. Clover, Mr. Fred Gibson and Dr. Ira L. Wiggins for assistance in the study of the Cactaceae of the Charleston Mountains and for specimens of and information regarding these and related species. Specimens of all of the species treated below except those of *Mammillaria tetrancistra* Engelm. have been widely distributed to the herbaria of the world. Types of the new species are all in the Clokey Herbarium now at the Bull. So. Calif. Acad. Sci. 37: 1-11. 1938; *l.c.* 38: 1-7. 1939; regarding these and related species. Specimens of all the spe- University of California, Berkeley.

KEY TO THE GENERA OF CACTACEAE

- Stems jointed, cylindrical or flat; leaves small, subulate, deciduous; areoles on tubercles or on flat surfaces, with numerous, barbed glochids; glochids and flowers produced from the same areoles; ovaries with areoles and glochids; spines barbed or not barbed 1. *Opuntia*
- Stems not jointed, cylindrical, without leaves; areoles on ridges or tubercles, without glochids; flowers produced above the areoles; ovaries with or without areoles, without glochids; spines not barbed.
- Stems ribbed; spines borne on definite ridges.
 - Flowers borne above old spine-bearing areoles, solitary, appearing lateral, purple or crimson; tube and ovary spiny; fruit colored, thin-skinned, spiny 2. *Echinocereus*
 - Flowers borne above young areoles, appearing sub-terminal in a circle near the top of plant; ovary scaly; fruit green, without spines 3. *Echinocactus*
- Stems not ribbed; spines borne on tubercles arranged in rows or scattered.

- Flowers lateral; tubercles not grooved on upper side; one or more of the spines hooked; fruit red; seeds black, rugose, with a thick corky base in our species 4. *Mammillaria*
- Flowers terminal; tubercles grooved on upper side; none of the spines hooked; fruit green or rose, ripening slowly; seeds brown, pitted, without a thick corky base 5. *Coryphantha*

KEY TO THE SPECIES OF OPUNTIA MILL.

Joints cylindrical and tuberculate.

Spines smooth, covered with loose, hyaline sheaths.

- Stem slender and solid, with a woody axis; tubercles flattened; spines solitary or absent 1. *O. ramosissima*

Stems thick and fleshy with a reticulated, cylindrical axis; tubercles raised; spines more than one.

- Tubercles two to three times as long as wide; fruit dry, with stout spines 2. *O. acanthocarpa*

Tubercles less than twice as long as wide.

- Plants erect, with one or few main stems; stems loosely branched; flowers yellow, tinged with red; fruit dry, with stiff spines on the upper areoles 3. *O. echinocarpa*

Plants low, bushy, without a main stem; stems compactly short branched; flowers greenish-yellow; fruit somewhat fleshy, yellow, with a few delicate, deciduous spines

4. *O. multigeniculata*

Spines rough, without sheaths; plants prostrate

5. *O. Parishii*

Joints flattened, not tuberculate.

Joints spineless; flowers magenta; fruit dry, spineless

6. *O. basilaris*

Joints spiny; flowers yellow.

Areoles 2-3 cm. apart; spines white or with brown base; fruit purple, juicy, spineless.

Fruit 3-3.5 cm. long, with green pulp; slopes above Griffith's mine at an elevation of 2450 meters

7. *O. charlestonensis*

Fruit 4-6 cm. long, with purple pulp; at elevations of 1200-1350 meters

8. *O. phaeacantha*

Areoles about 1 cm. apart; spines white (occasionally brownish); fruit dry, spiny.

Spines acicular, 3-5 cm. long and bristle-like, up to 12 cm. long

9. *O. erinacea*

Spines all acicular, stiff, not over 2-3 cm. long ..

10. *O. polyacantha*

1. *OPUNTIA RAMOSISSIMA* Engelm. Am. Jour. Sci. ser. 2, 14: 339. 1852.

Mohave and Colorado deserts, from California, Nevada and Arizona south to Sonora. Local habitat, widely scattered in sandy or gravelly soil in the Larrea Belt. Best developed in sandy soil east of Wilson's ranch where the plants are about one-half meter tall. Cottonwood Springs, altitude 1030 meters, *Clokey 8036*; E-Spear ranch, altitude 1640 meters, *Train 1743*; south of Indian Springs, altitude 1200 meters, *Clokey 8026*; east of Wilson's ranch, altitude 1100 meters, *Clokey 8437*. May to August.

2. *OPUNTIA ACANTHOCARPA* Engelm. & Bigel. Proc. Am. Acad. 3: 308. 1856.

Mohave and Colorado deserts from California to southern Utah, south to Sonora. Local habitat, in sandy or gravelly soil in the Larrea Belt. Most abundant at Wilson's ranch. Wilson's ranch, altitude 1150 meters, *Clokey* 8024, 8433. June.

3. *OPUNTIA ECHINOCARPA* Engelm. & Bigel. Proc. Am. Acad. 3: 305. 1856.

Mohave and Colorado deserts of California, east to Utah and Arizona, south to Lower California. Local habitat, local in the upper Larrea and lower Juniper belts. Most abundant in Kyle Canyon at an elevation of about 1600 meters. Kyle Canyon, *Clokey* 7202, 8025. June.

4. *Opuntia multigeniculata* Clokey sp. nov. E Sect. *Cylindropuntia*, *humilis*, *subadscendens*, *habitu conferta*, plus minusve 0.5 m. alta, ad 1.5 m. lata, ramorum ligno debili, reticulato; ramis majoribus depresso-tuberculatis, ca. 1.5–2 cm. crassis, geniculis lateralibus numerosis, 3–5 cm. longis, ca. 2 cm. crassis, tuberculis confertis 4–6 mm. longis, 2–3 mm. latis, 4–5 mm. altis, apice areola pallide brunneo-lanosa, 4–5 mm. longa, 2–2.5 mm. lata coronatis; aculeis ca. 12, geniculum ipsum fere occultantibus, delicatis, vaginis albidis barbulatis; aculeis centralibus 2–4, 15–18 cm. longis, lateralibus gracillimis; foliis teretibus apiculatis ca. 2 mm. longis; glochidiis ex areola summa albidis, 1.5 mm. longis; floribus in apice geniculi aggregatis, ca. 2.5 cm. longis totidemque latis; ovario conferte tuberculato, areolis prominentibus, ellipsoideis, lana pallide brunnea; aculeis paucis, pergracilibus, deciduis; perianthii laciniis pallide viridi-luteis, spatulatis, obtusis apiculatisve, 15–18 mm. longis; stylo cum stigmatibus luteis, stigmatum lobis 6–8; staminibus luteis; fructu globoso, luteo, subcarnoso, ca. 2 cm. longo, tuberculato, exaculeato, profunde umbilicato; hypanthii cavo pulpa incolora farcto; seminibus rotundatis, pallide luteis, haud nitidis, levibus, 2.5–3 mm. diametientibus, commissura brevi, lata, manifesta.

A low, semi-ascending, compact *Cylindropuntia*, 0.5 m. or less high, up to 1.5 m. wide, with stems having a weak, reticulated, woody framework; main stems low tuberculate, about 1.5–2 cm. thick, with crowded lateral joints 3–5 cm. long, about 2 cm. thick; lateral joints with closely placed tubercles, 4–6 mm. long, 2–3 mm. wide, 4–5 mm. high, with the entire upper end of the tubercle occupied by an areole 4–5 mm. long, 2–2.5 mm. wide, filled with light tan-colored wool; spines about 12, almost concealing the surface of the joints, delicate, white-sheathed, barbed; 2 to 4 central spines 15–18 mm. long; lateral spines very slender; leaves terete, apiculate, about 2 mm. long; glochids white, 1.5 mm. long, from the upper end of the areoles; flowers clustered at the tip

of the joints, about 2.5 cm. long and broad; ovary closely tuberculate; areoles prominent, oval, filled with light tan-colored wool; spines few, very delicate, deciduous; perianth-segments light greenish-yellow (Ridgway's Col. Stand. and Nom. plate 5, 25 YG-Y, b), spatulate, obtuse or apiculate, 15-18 mm. long; style and stigmas yellow; stigma lobes 6 to 8; stamens yellow; fruit globose, yellow, with somewhat fleshy walls, about 2 cm. high, tuberculate, spineless, deeply umbilicate; seed cavity filled with colorless jelly; seeds circular, light yellow, dull, smooth, 2.5-3 mm. in diameter; commissure short, broad, distinct.

Definitely known only from the type locality on an open, rocky ridge east of Wilson's ranch, Charleston Mountains, Clark County, Nevada, along road from Blue Diamond mill to the mine, at an elevation of 1400 meters; *Clokey* 8430 (type), 8639, 8760. Flower, May; fruit, July to September.

Mr. Fred Gibson of the Boyce Thompson Southwestern Arboretum states that plants similar to this are found near Prescott, at Congress, and along the Colorado River in Arizona. These have not been examined.

Opuntia multigeniculata is intermediate between the series Thurberianae and Echinocarpae. In the Echinocarpae it is closest to *O. echinocarpa* Engelm. & Bigel. It differs from this species in having weaker, less woody, shorter and more crowded stems. The fruit of *O. echinocarpa* is dry. The somewhat fleshy fruit and the seeds resemble *O. Whipplei* Engelm. & Bigel. The joints, however, are thicker, shorter, more crowded and more thickly armed than *O. Whipplei*. In the original description Engelm. and Bigelow (Proc. Am. Acad. 3: 307. 1856), state that the color of the flowers of *O. Whipplei* is red. Britton and Rose (Cact. 1: 55-56. 1919) and Benson and Thornber (Cact. Ariz. 36. 1940) give the color of the flowers as yellow.

Neither *O. echinocarpa* nor *O. Whipplei* grow near the type locality of *O. multigeniculata*.

5. *OPUNTIA PARISHII* Orcutt, West. Am. Sci. 10: 81. 1896.

Mohave Desert of California and southern Nevada. Local habitat, locally abundant in sand or gravelly soil in the Larrea Belt at elevations of 1000 to 1200 meters. Cottonwood Springs, *Clokey* 8028; south of Indian Springs, *Clokey* 8027; east of Wilson's ranch, *Clokey* 8434. June.

Drifting sand usually partially covers the old joints. This is a characteristic plant that could not be mistaken for any other *Cylindropuntia* in this region.

EXPLANATION OF THE FIGURES, PLATE 4.

PLATE 4. CACTACEAE OF THE CHARLESTON MOUNTAINS, NEVADA. Fig. A, *Opuntia multigeniculata* Clokey. Fig. B, *Opuntia acanthocarpa* Engelm. and Bigel. Fig. C, *Opuntia charlestonensis* Clokey.

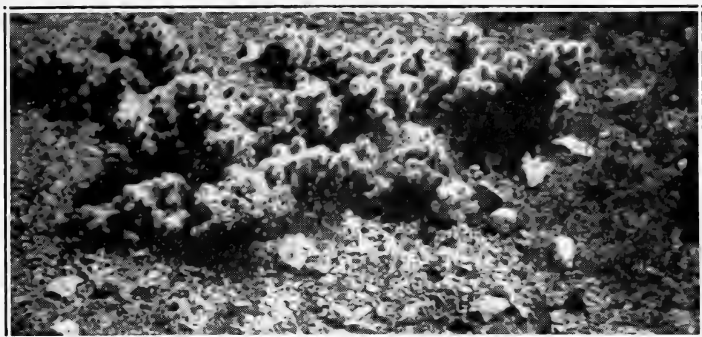


FIGURE A

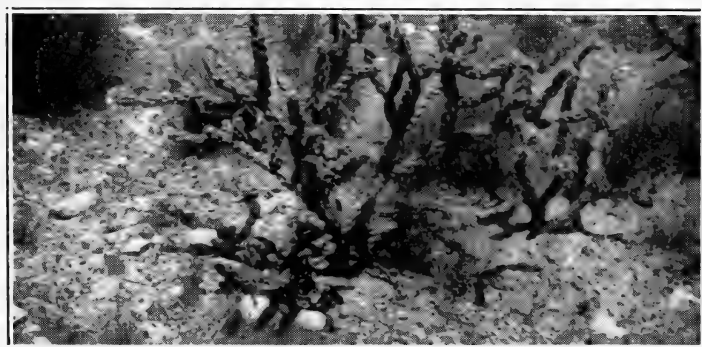


FIGURE B



FIGURE C

PLATE 4. CACTACEAE OF THE CHARLESTON MOUNTAINS, NEVADA.

6. *OPUNTIA BASILARIS* Engelm. & Bigel. Proc. Am. Acad. 3: 298. 1856.

Colorado and Mohave Deserts and surrounding mountains from California to Utah, south to Sonora. Local habitat, widely scattered in the Larrea Belt below 2000 meters. Clark Canyon, *Clokey & Anderson 7201*; southeast Indian Springs, *Train 1759*; Kyle Canyon, *Clokey 7205, 8032*; Trout Creek Canyon, *Clokey & Anderson 7206*. May.

7. *Opuntia charlestonensis* Clokey sp. nov. Humilis, patens ad 0.5 m. alta, 1.5 m. lata, ramis primo adscendentibus demum prostratis, tum geniculis 2-3 junioribus tantum suberectis; geniculis apicalibus vel lateralibus, ovalibus vel obovatis, saepius apice rotundatis, 10-18 cm. longis, 10-12 cm. latis, viridi-lutescentibus, primo vere rubentibus; areolis rotundatis vel ovatis, 5-6 mm. latis, 2-2.5 cm. distantibus; glochidiis 3-4 mm. longis, pallide brunneis in areolae apice; aculeis 4-6 acicularibus longitudine ludentibus, longissimis ad 4.5 cm., subcomplanatis tortisque, undique vertentibus, albidis vel albidis basi pallide brunneis; floribus primo laete luteis demum conferte roseis rubro-suffusis, 4-6 cm. longis, ca. 4 cm. latis; perianthii laciniis externis ovatis, acutis, mucronatis, internis ovatis, apice rotundatis saepius mucronatis; staminibus luteis; stylo cum stigmatibus luteis vel rubescentibus; fructu ellipsoideo 3-3.5 cm. longo, 1.5-2 cm. crasso, sordide purpurascente, cortice externo pulpaque viridibus; seminibus applanatis, 4-5 mm. diametientibus.

A low spreading plant up to 0.5 m. high, 1.5 m. wide, the main branches at first ascending, later prostrate with only the younger two to three joints ascending; joints arising from the faces as well as from the edges of older joints, oval or obovate, mostly rounded at tip, 10-18 cm. long, 10-12 cm. wide, yellowish-green, in the spring purplish; areoles circular or oval, 5-6 mm. across, 2-2.5 cm. apart; glochids in the upper part of the areoles, 3-4 mm. long, light brown; spines four to six, acicular, varying in length, the longest up to 4.5 cm. long, somewhat flattened and twisted, spreading in all directions, white or white with light brown base; flowers clear yellow at first, turning salmon tinged with red, 4-6 cm. long, about 4 cm. wide; outer perianth-segments ovate, acute, mucronate; inner segments ovate, rounded at tip, usually mucronate; stamens yellow; style and stigmas yellow or reddish tinged; fruit oval, 3-3.5 cm. long, 1.5-2 cm. thick, dull reddish-purple, with green rind and pulp; seeds flat, 4-5 mm. in diameter.

Known only from hillsides adjacent to Griffith's mine, associated with *Pinus monophylla* Torr. & Frém. and *P. scopulorum* (Engelm.) Lemmon, at an elevation of about 2450 meters, *Clokey 7203, 7592, 8029* (type), *8688, 8770*. Flower, July to August; fruit, September to October.

As suggested by Dr. Ira L. Wiggins, *O. charlestonensis* is most closely related to *O. megacarpa* Griffiths, a plant of the western edges of the Mohave and Colorado deserts in California. *O. megacarpa* has joints 20–30 cm. long, fruit 7–12 cm. long and seeds 7–8 mm. in diameter.

8. *OPUNTIA PHAEACANTHA* Engelm. in Gray, Mem. Am. Acad. 4: 52. 1849.

Texas and Chihuahua to Arizona and the Charleston Mountains, Clark County, Nevada. Local habitat, among *Quercus*, *Fraxinus* and *Amelanchier* at Wilson's ranch and in open wash on gravelly soil at the mouth of Pine Canyon. Wilson's ranch, altitude 1180 meters, *Clokey* 8031, 8424, 8431, 8761; mouth of Pine Canyon, altitude 1350 meters, *Clokey* 8656, 8685. Flower, May to June; fruit, July to August.

The plants of *O. phaeacantha* Engelm. from the Charleston Mountains do not agree entirely with the original description but, except for the size of the fruit, fall well within the range included in that highly variable species by Britton and Rose (Cact. 1: 144. 1919), and Benson and Thornber (Cacti Ariz. 58. 1940). Boissvain and Davidson (Colo. Cacti. 12. 1940) give the size of the fruit as 4 to 6 centimeters in length, which agrees with the fruit of our plants. At Wilson's ranch, where the joints are up to 20 centimeters long, *O. phaeacantha* grows among *Quercus*, *Fraxinus* and *Amelanchier*. This protection may well account for the unusual size of the joints. The red color shown in winter and spring on the joints at Pine Canyon, but not at Wilson's ranch, is evidently due to cold. Cuttings from the Pine Canyon station grown in South Pasadena remain green throughout the winter.

9. *OPUNTIA ERINACEA* Engelm. Proc. Am. Acad. 3: 301. 1856.

Mohave Desert of California, east to Utah and Arizona. Local habitat, most abundant on a dry ridge east of Wilson's ranch along road from Blue Diamond mill to the mine, at an elevation of 1200 to 1400 meters. Mountain Springs, elevation 1700 meters, *Clokey* 8423; ridge east of Wilson's ranch, *Clokey* 8033, 8436. June to July.

10. *OPUNTIA POLYACANTHA* Haworth, Suppl. Succ. 82. 1819.

North Dakota to Washington, south to Texas, Nevada and Arizona. Local habitat, occasional in the Juniper Belt. Harris Springs road, elevation 1800 meters, *Clokey* 7591; Lee Canyon, elevation 1800 meters, *Clokey* 7204; Willow Springs, elevation 1200 meters, *Clokey* 8030.

KEY TO THE SPECIES OF ECHINOCEREUS ENGELM.

- | | |
|--|--------------------------|
| Plants forming large clusters with many heads; spines | |
| few, white or gray, long and flexuous; flowers scarlet, | |
| funnelform | 1. <i>E. mohavensis</i> |
| Plants with few heads, ascending; spines white to brown, | |
| stout, curved; flowers purple, broad | 2. <i>E. Engelmannii</i> |

1. *ECHINOCEREUS MOHAVENSIS* (Engelm. & Bigel.) Rümpler, Först. Handb. Cact. 2: 803. 1885.

Cereus mohavensis Engelm. & Bigel. in Engelm. Am. Acad. Arts and Sci. Proc. 3: 281. 1856.

Southeastern California to southern Utah, northern Arizona and south to Mexico. Local habitat, occasional as single plants in the Juniper Belt extending in places to the Pinyon and Yellow Pine belts. Grows in gravelly soil and on rock ledges. Cathedral Rock, elevation 2425 meters, *Clokey* 7211; Clark Canyon, elevation 1800 meters, *Clokey & Anderson* 7200; Charleston Park, elevation 2300 meters, *Clokey* 8034, elevation 8000 feet, *Alexander* 755; Kyle Canyon, elevation 2425 meters, *Clokey* 7210, elevation 1700 to 2400 meters, *Clokey* 8435; Lee Canyon, elevation 2670 meters, *Clokey, Clokey & Baker* 7597. May, June.

2. *ECHINOCEREUS ENGELMANNII* (Parry) Rümpler, Först. Handb. Cact. 2: 805. 1885.

Cereus Engelmannii Parry ex Engelm. Am. Jour. Sci. ser. 2, 14: 338. 1852.

Mohave and Colorado deserts of California, east to Utah and Arizona, south to Mexico. Local habitat, widely scattered in the Larrea and lower Juniper belts at elevations up to 1400 meters. Kyle Canyon, *Clokey* 7590; Trout Creek Fan, *Clokey* 7207.

KEY TO THE SPECIES OF ECHINOCACTUS MILL.

Spines stout, flattened, annulate; flowers yellow.

Stems globose, aggregate; axils of scales of ovary and fruit woolly

1. *E. polycephalus*

Stems simple, globose to cylindrical; axils of scales on ovary and fruit not woolly

2. *E. acanthodes*

Spines subulate, not annulate; scales on ovary and fruit few, without wool in the axils; flowers amaranth purple (Ridgway) to pink

3. *E. Johnsonii*

1. *ECHINOCACTUS POLYCEPHALUS* Engelm. & Bigel. Proc. Am. Acad. 3: 276. 1856.

Eastern Mohave Desert of California, east to Utah and Arizona, south to northern Sonora. Local habitat, sparsely scattered in gravelly soil or on rock ledges in the Larrea Belt. South of Indian Springs, elevation 1300 meters, *Clokey* 7598, elevation 1250 meters, *Clokey* 8432. July.

2. *ECHINOCACTUS ACANTHODES* Lemaire, Cact. Gen. Nov. Sp. 106. 1839.

Ferocactus acanthodes (Lemaire) Britton & Rose, Cact. 3: 129. 1922.

Southern California to southern Nevada, Arizona and Lower California. Local habitat, on gravelly hills and rock ledges in the Larrea Belt at elevations of 1100 to 1400 meters. Most abundant on a ridge east of Wilson's ranch along road from Blue

Diamond mill to the mine. South of Indian Springs, *Clokey* 7212, 7593; rocky ridge east of Wilson's ranch, *Clokey* 8428, 8429.

3. *ECHINOCACTUS JOHNSONII* Parry in Engelm. Bot. King's Geol. Expl. 40th Par. 5: 117. 1871.

Ferocactus Johnsonii (Parry), Britt. & Rose, Cact. 3: 141. 1922.

Southwestern Utah, northwestern Arizona, southern Nevada and extreme eastern Inyo County, California. Although *Echinocactus Johnsonii* so far has not been found in the Charleston Mountains it is to be expected since it occurs both to the east and to the west of the range. It occurs very locally on hot, steep, gravelly slopes in the Larrea Belt and should be looked for on the lowest foothills. East of the range: Frenchman's mine, 7 miles east of Las Vegas, elevation 630 meters, *Clokey* 5900; ridge south of Logandale, Clark County, elevation 550 meters, *Clokey* 5901. West of the range the type locality of *Echinocactus Johnsonii* Parry var. *octocentrus* Coult. is in the mountains east of Resting Springs, Inyo County, California.

The number of central spines is rather indefinite and variable even on the same plant. The spines graduate in thickness and length from the largest centrals to the shortest laterals so that there is no satisfactory line of demarcation.

MAMMILLARIA HAW.

1. *MAMMILLARIA TETRANCISTRA* Engelm. Am. Jour. Sci. ser. 2, 14: 337. 1852.

Phellosperma tetrancistra (Engelm.) Britt. & Rose, Cact. 4: 60. 1923.

Southern Utah to Nevada, Arizona and southeastern California. Infrequent and isolated. Local habitat, known in the Charleston Mountains from a single specimen collected on a gravelly hillside in the Larrea Belt south of Indian Springs at an elevation of 1250 meters, *Clokey* 8037 (*Clokey* Herbarium).

KEY TO THE SPECIES OF CORYPHANTHA (ENGELM.) LEMAIRE

- | | |
|--|----------------------|
| Flowers 2-3 cm. long, straw-colored with pinkish midrib to tinged with pink throughout; fruit green; seeds brown; Larrea and Juniper belts | 1. <i>C. deserti</i> |
| Flowers 3.5-4.5 cm. long, eugenia red to old rose (Ridgway); fruit more or less rose-colored; seeds reddish-brown; associated with <i>Pinus monophylla</i> Torr. & Frem., <i>P. scopulorum</i> (Engelm.) Lemmon and <i>Cercocarpus ledifolius</i> Nutt. | 2. <i>C. rosea</i> |

EXPLANATION OF THE FIGURES, PLATE 5.

PLATE 5. CACTACEAE OF THE CHARLESTON MOUNTAINS, NEVADA. Figs. a, b, *Opuntia acanthocarpa* Engelm. and Bigel. Figs. c, d, *Opuntia echinocarpa* Engelm. and Bigel. Figs. e, f, g, *Opuntia multigeniculata* Clokey. Fig. h, *Opuntia echinocarpa* Engelm. and Bigel. Fig. i, *Coryphantha rosea* Clokey.

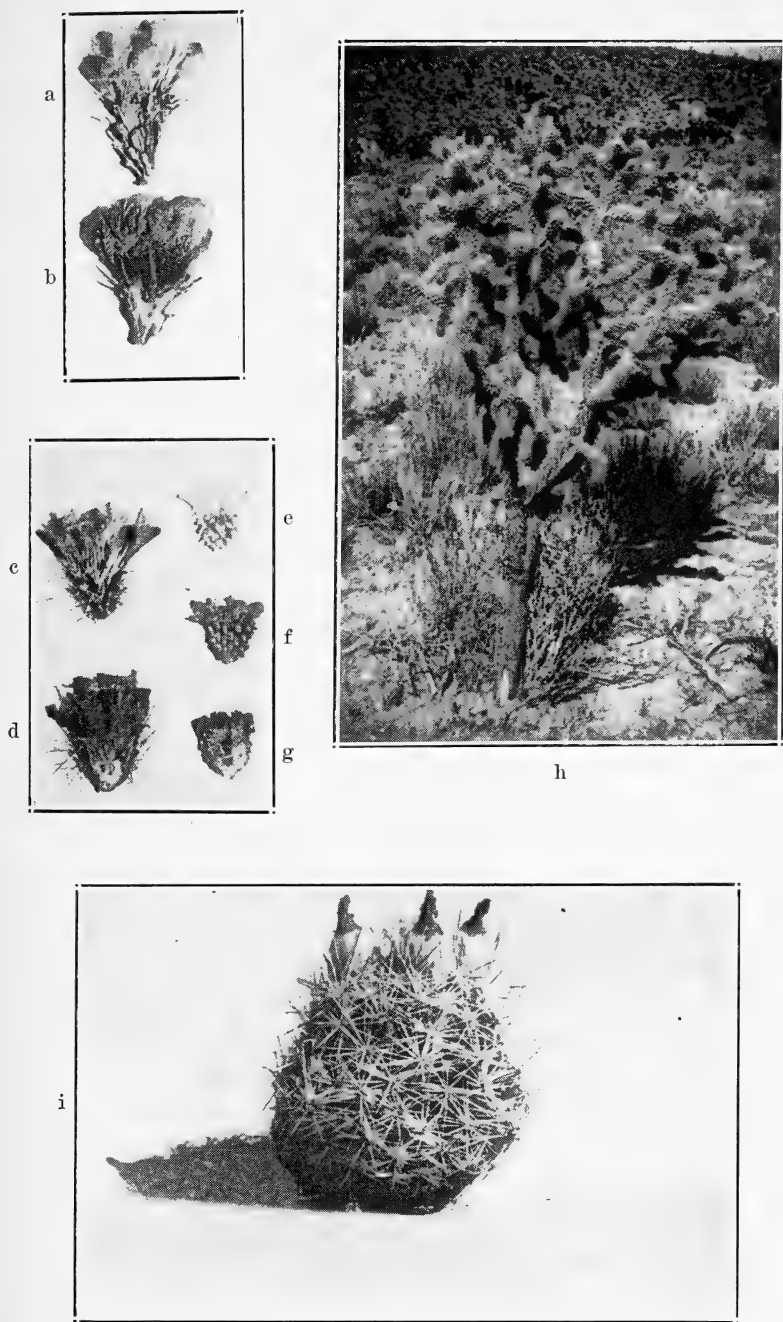


PLATE 5. CACTACEAE OF THE CHARLESTON MOUNTAINS, NEVADA.

1. *CORYPHANTHA DESERTI* (Engelm.) Britt. & Rose, Cact. 4: 46. 1923.

Mammillaria deserti Engelm. Bot. Calif. 2: 449. 1880.

Eastern Mohave Desert of California to southern Nevada and possibly northwestern Arizona. Local habitat, widely scattered on gravelly hills and in washes in the Larrea and lower Juniper belts at elevations of 1100 to 1900 meters. It is most abundant in the wash below Rocky Gap Springs. The flowers, which last several days, are open only in the afternoons. Harris Springs road, *Clokey* 7794; Kyle Canyon at mouth, *Clokey* 7594; Kyle Canyon at junction of Harris Springs road, *Clokey* 8425, 8426; Rocky Gap Springs, *Clokey* 8718.

Jepson (Fl. Calif. 2: 550. 1936) regards *C. deserti* as a synonym of *C. chlorantha* (Engelm.) Britt. & Rose and reports the flower color as yellow or stramineous. *C. chlorantha* (*Mammillaria chlorantha* Engelm. in Rothr. Bot. Wheeler 127. 1878) was originally described as having yellow or greenish-yellow flowers and white stigma lobes. Engelmann described the petals of *M. deserti* (Bot. Calif. 2: 449. 1880) as light straw color turning to purplish at tips. On the examination of the flowers of hundreds of plants in the Charleston Mountains and over 300 dried flowers the writer failed to find a single flower without a distinct pink tinge at least on the midrib of the perianth-segments. This pink color was not confined to the tips but extended throughout the length of the petals. The flowers are 2.5–3 cm. long; the stigma lobes are yellow or partially tinged with pink. Several collections of *C. deserti* in 1942 by J. P. Hester from southern Clark County, Nevada, and eastern San Bernardino County, California, one of the latter from near to or possibly from the type locality, are excellent matches for the Charleston Mountains plants. *F. W. Gould* 1589 and *Hester Utah* 1, both from the Beaverdam Mountains west of St. George, Utah, from near the type locality, agree with the original description of *C. chlorantha*. The flowers are 3.5–4 cm. long, the petals are yellow or greenish-yellow without a trace of pink, the stigma lobes are yellowish. Hester reports that the flowers of *C. chlorantha* are fragrant while those of *C. deserti* are not. From the study of this material it is evident that *C. deserti* should not be considered even as a variety of *C. chlorantha*.

2. *Coryphantha rosea* Clokey sp. nov. Globosa vel ovata, 4–15 cm. alta, 4–10 cm. crassa, tota aculeis dense tecta; tuberculis cylindricis, 10–15 mm. longis, supra totis sulcatis, sulcis areolisque tenellis albido-lanosis; aculeis 28–35 acicularibus, centrali semper angulo recto insidente, 5–10 mm. longis, saepius apice rubentibus (raro nigricantibus), centrali in lateralibus aculeis colore crassitudine intermediis sensim transeunte; floribus in axillis tuberculorum ad plantae ipsius apicem rubris vel roseis, 3.5–4.5 cm. longis, squamis tubi laciniisque externis e basi angus-

tatis, acuminatis, longe fimbriatis; laciniis internis similibus neque fimbriatis; filamentis luteis; stylo cum stigmatibus luteis vel roseis, stigmatis lobis linearibus; fructu ovoideo, praesucculento, perianthii reliquiis siccis persistentibus, tarde maturante, plus minusve rubro-colorato, 2–2.5 cm. longo, 1.2–1.4 cm. crasso; semine rubro-brunneo, foveolato, 2 mm. longo, 1.25 mm. crasso.

Globular to oval, simple, 4–15 cm. high, 4–10 cm. thick; armament dense, hiding the surface of the plant; tubercles cylindric, 10–15 mm. long, grooved through the length on the upper side, with tufts of white wool in the axils and areoles of the younger tubercles; spines 28 to 35, acicular, central permanently at right angles to the surface of the plant, 5–10 mm. long, more or less tipped with reddish-brown (rarely black), the central spines grading in thickness and depth of color to the laterals, on the upper, younger tubercles the spines are nearly erect, with age the spines lose their color and radiate almost at right angles to the tubercles; flowers borne in the axils of the young spiny tubercles forming a circle at the top of the plant, eugenia red to old rose (Ridgway's Color Stand. and Nom. plate XIII, I' red), 3.5–4.5 cm. long; scales on the tube and outer perianth-segments tapering from the base, acuminate, long fimbriate; inner perianth segments similar but not fimbriate; filaments yellow; style and stigmas yellow or rose; stigma-lobes linear; fruit oval, very juicy, with the withered perianth persisting, ripening slowly, more or less colored with eugenia red or old rose, 2–2.5 cm. long, 1.2–1.4 cm. thick; seeds reddish-brown, pitted, 2 mm. long, 1.25 mm. wide.

Widely but sparsely scattered. Cold Creek, with *Juniperus utahensis* (Engelm.) Lemmon at 1850 meters, *Clokey* 8035; ridge south of Deer Creek, with *Cercocarpus ledifolius* Nutt. at 2650 meters, *Clokey* 7595, 7596; ridge along Lee Canyon with *Juniperus utahensis* (Engelm.) Lemmon at 1900 meters, *Clokey* 7209; Kyle Canyon to Deer Creek with *C. ledifolius* and *Pinus monophylla* Torr. & Frém. at 2400 meters, *Clokey* 7208, 8038 (type); Kyle Canyon with *Pinus scopulorum* (Engelm.) Lemmon at 2200 meters, fruit ripe, *Clokey* 8769. Flower, June; fruit, September, October.

Coryphantha rosea is quite similar to *C. deserti* and *C. chlorantha* (Engelm.) Britt. and Rose in the appearance of the armament and in the shape and ciliation of the perianth-segments. It differs from *C. chlorantha* in the color of the flowers and fruit and from *C. deserti* in the size and color of the flowers and in the color of the fruit. It grows at higher elevations than *C. chlorantha* and *C. deserti* and, so far as known, is confined to the middle elevations of the Charleston Mountains. No intermediate plants have been found. *C. Alversonii* (Coul.) Orcutt, a plant growing at lower elevations in extreme southeastern California, has darker, heavier spines and is reported to have white stigma-lobes and green fruit.

South Pasadena, California,
April, 1942.

NOTEWORTHY PLANTS FROM IDAHO. II

ARTHUR CRONQUIST

During the summer of 1941 Mrs. Cronquist and I spent two months collecting plants in central Idaho. A complete set is deposited at the Missouri Botanical Garden, and nearly complete sets at the Gray Herbarium and the University of Idaho, Southern Branch; partial sets are deposited at the University of Minnesota and the Utah State Agricultural College. Several collections represent plants not previously known to occur in the state; a few are apparently undescribed. In the following discussion, unless otherwise indicated, the collection numbers are my own.

There are in Idaho at least two entities that have commonly been referred to *Melica bulbosa* Geyer ex Port. and Coult. One, the usual form of the species, is single-stemmed or loosely caespitose, with obvious bulbs at the bases of the culms. The other is very densely caespitose, growing in large tufts, with the bases of the culms only slightly if at all bulbous. Although the degree of bulbousness of the culms is known to be a variable character in *M. bulbosa*, the appearance of the caespitose form is so striking that in the field it might well be taken for a different species. The clumps are very dense, and difficult to separate into specimens suitable for herbarium sheets. It may be significant that in 1899 Aven Nelson considered the habit of specimens he collected so remarkable that he noted on the labels sent out with them, "in dense tufts with matted roots." Dr. W. S. Boyle, of the University of California, who is making a cytogenetic study of the genus, writes me that the caespitose plants I sent him do not differ sufficiently from the usual form to warrant separate treatment. Since the two forms are decidedly different in appearance, and are readily distinguishable in the field, I prefer to regard them as two varieties of one species.

MELICA BULBOSA Geyer var. *typica* nom. nov. *M. bulbosa* Geyer ex Port. and Coult. Syn. Fl. Colo. 149. 1874.

MELICA BULBOSA Geyer var. *caespitosa* var. nov. Planta caespitosa culmis ad basim haud vel vix bulbosis, cetera similis var. *typicae*.

Type. Open rocky granitic slope above west side of Alturas Lake, Blaine County, Idaho, altitude 7200 feet, June 22, 1941, 2603 (Missouri Botanical Garden; isotypes, Utah State Agricultural College, University of Idaho, Southern Branch). Cotypes. IDAHO. Hillside above Mill Creek, 12 miles west of Challis, Custer County, altitude 7800 feet, July 8, 1941, 2977; granitic outcrop above Wildhorse Creek, 25 miles southwest of Chilly, Custer County, altitude 7900 feet, July 23, 1941, 3354. WYOMING. Teton Mountains, Uintah County, August 16, 1899, Nelson and Nelson 6540.

SITANION HANSENI \times **AGROPYRON SPICATUM**. On a rocky granitic hillside above Bull Trout Lake, Boise County, 35 miles west of Stanley at an altitude of 7000 feet, a colony of highly variable hordeaceous grasses was observed. A few spikes of the extreme of the robust plants were taken with the other plants of the same number (3615). A mile upstream and 200 feet higher on the same hillside, specimens of *Agropyron spicatum* (Pursh) Scribn. and Smith were seen and collected (3635). On examining my number 3615 in the herbarium, I find that the large spikes are quite uniform and represent *Sitanion Hansenii* (Scribn.) J. G. Smith. Other specimens of this number are so extremely variable as to be abnormal, transcending the differences between *Sitanion* and *Agropyron*. Spikes with all the spikelets solitary and with all the spikelets paired at the nodes occur on the same plant. One culm branches at the summit into two variable spikes. Tests made on a few rachises indicate that they disarticulate, but only on considerable urging. Individual portions of some of the spikes are strongly reminiscent of *Agropyron spicatum*. It is my opinion that the specimens represent a natural hybrid between *Sitanion Hansenii* and *Agropyron spicatum*.

Carex obovoidea sp. nov. Planta caespitosa, culmi 20–40 cm. alti, vaginae ventraliter rubro-maculatae, ad apices rubiginosae, inferae aphyllae; spiculae plures androgynae, coarctatae in capitulum 15–30 mm. longum, 8–20 mm. latum; squamae late ovatae, castaneae, marginalibus perspicuae; utriculi 3–3.5 mm. longi, 1 mm. lati, plerumque attenuatis ab basibus spongiositurgidus, dorsaliter paucinervi, ventraliter enervi; achenium obovatum, haud vel vix stipitatum, 1.5 mm. longum, minus quam 1 mm. latum; stigmata 2.

Caespitose, 20–40 cm. high, aphyllopodic; sheaths red-dotted ventrally and copper tinged at the mouths; spikes small, numerous in an ovoid or oblong head 15–30 mm. long, 8–20 mm. wide, sometimes slightly interrupted below, androgynous; scales broadly ovate, brown, with conspicuous hyaline margins; perigynium corky-thickened at the base, yellowish brown, changing to green upwards, or somewhat green-margined, 3–3.5 mm. long, 1 mm. wide, tapering from base to apex, or a little more strongly narrowed near the middle, prominently few-nerved dorsally, nerveless ventrally, margins serrulate, beak obliquely cut and dark brown at the tip; achene lenticular, obovate, broadest above the middle, scarcely stipitate, 1.5 mm. long, less than 1 mm. wide; stigmas 2.

Type. Mossy rocky meadow along tiny spring above Beaver Creek, near Marsh Creek, 25 miles northwest of Stanley, Custer County, Idaho, altitude 6500 feet, July 3, 1941, 2872 (Missouri Botanical Garden; isotypes at University of Idaho, Southern Branch and Utah State Agricultural College).

This species is a member of the small section *Vulpinae*, as treated by Mackenzie (1). It differs from the related *C. neurophora* Mack. and *C. nervina* Bailey in having the perigynia ventrally nerveless, and the sheaths ventrally red-dotted and copper-colored at the mouths. It differs from *C. Cusickii* Mack., of the related section *Paniculatae*, in its shorter stature, more contracted inflorescence, spongy-thickened perigynium-base, and tapering rather than abruptly contracted perigynium. It differs from all of these in its obovate achenes.

Astragalus reclinatus sp. nov. Planta perennis prostrata, caulibus 1 mm. crassis ad 50 cm. longis plus minusve strigosis; folia similiter strigosa foliolis 1-5 (plerumque 3) foliolo extremo 20-30 mm. longo, 3-5 mm. lato, eis lateralibus reductis vel defectis, stipulae virides parvulae 2-3 mm. longae, flores albidipurpurei 12 mm. longi alis rostrum superantibus calyce 6 mm. longo, fructus sessilis 15-17 mm. longus, 3-4 mm. latus albido-strigosus suturis prominentibus haud intrusis.

Stems several from a perennial tap root, prostrate, spreading, up to 50 cm. long or more, about 1 mm. thick, green, striate, more or less pubescent with thick, short, nearly or quite basifixed hairs; leaves similarly pubescent, scattered, short-petiolate, with 1-5 (commonly 3) linear to narrowly lanceolate leaflets, the terminal one enlarged, mostly 20-30 mm. long and 3-5 mm. wide, tapering and acute at both ends, the lateral ones commonly somewhat reduced, mostly 10-20 mm. long and 1-3 mm. wide, sometimes absent; stipules tiny, green, triangular or ovate, free, 2-3 mm. long; flowers whitish, with a trace of purple, mostly 2-10 in short racemes; banner 12 mm. long, abruptly bent nearly at right angles 5 mm. from the base, the expanded portion 9 mm. long, 8 mm. wide and suborbicular when spread out; wings about 4 mm. wide and 11 mm. long, including the 5 mm. claw; keel 9 mm. long, 4 mm. high at the end, blunt; calyx with short black and white hairs intermingled in varying proportions, the tube 3.5-4 mm. long, the teeth triangular and about 2 mm. long; pod sessile, 1-celled, mostly 15-17 mm. long and 3-4 mm. wide, little-compressed, closely strigose with short white hairs, sutures prominent and not at all intruded.

Type. Moist alkaline bottoms along roadside two miles south of Dickey, Custer County, Idaho, altitude 6300 feet, July 14, 1941, 3086 (University of Minnesota; isotypes at Missouri Botanical Garden, Utah State Agricultural College and University of Idaho, Southern Branch).

This species of the section *Homalobus* is related to *A. flexuosus* Dougl. ex G. Don and the polymorphic *A. decumbens* (Nutt. ex T. & G.) Gray. The latter is common in the general area from which the type of *A. reclinatus* was taken, but was not seen in the immediate vicinity, nor have I ever seen it in the same type of

habitat. *A. flexuosus*, predominantly a species of the great plains, is not known to occur in Idaho.

The most conspicuous difference between *A. reclinatus* and its close relatives is its prostrate habit. Probably more important is the type of leaf. In *A. flexuosus* the lateral leaflets are several to numerous and well developed. The leaves of *A. decumbens* are highly variable, the leaflets often being in part reduced to phyllodia, but the terminal leaflet is affected as much as the others, and variation in that direction connects the species with the closely related *A. diversifolius* Gray, a rush-like plant in which the leaves are reduced to naked or nearly naked narrow rachises. In *A. reclinatus* the tendency is for the terminal leaflet to be enlarged at the expense of the others. None of the leaves on my specimens have more than five leaflets, and some are quite simple.

The flower, although superficially resembling that of the larger-flowered types of *A. decumbens* ("*A. hylophilus*" for example), shows its own distinctive differences. In *A. decumbens* the wings scarcely surpass the keel; in *A. reclinatus* the wings obviously surpass the keel, though not so prominently as in *A. flexuosus*. The upward widening of the pods commonly found in *A. decumbens* is inconspicuous or absent in *A. reclinatus*. The cross section of the pod is less compressed than in *A. decumbens*, and a little more so than in *A. flexuosus*. The stipules in *A. reclinatus* are tiny and green; in *A. flexuosus* and *A. decumbens* they are larger, mostly 5 mm. long or more, and somewhat scarious.

Although *A. reclinatus* is represented by only one collection, its distinguishing features, extending from technical characters of the flower to leaf type and habit, are so pronounced that I see little room for doubt as to the validity of the species.

GENTIANA CALYCOSA Griseb. subsp. *ASEPALA* Maguire. Madroño 6: 151. 1942. *G. idahoensis* Gandoger, Bull. Bot. Soc. Fr. 65: 60. 1918.

This recently described entity is represented in my collections by the following numbers: 3640, 3681, 3756, and 3757. Prior to the publication of Maguire's paper (2), this material had been identified as *G. idahoensis* Gandoger, the type of which was collected by Evermann at Pettit Lake, Blaine County, Idaho. At that time I doubted that it was more than subspecifically distinct from *G. calycosa*. It is now evident that *G. idahoensis* should be added to the synonymy of *G. calycosa* subsp. *asepala*.

Agastache Cusickii (Greenm.) Heller was described from the Steens Mountains, Oregon, and is known to Peck (3) only from the Steens Mountains. An isotype is in the University of Minnesota herbarium. A small *Agastache* collected in Custer County, Idaho, closely resembles *Agastache Cusickii* in most respects, but differs in being only 10–15 cm. tall, herbaceous nearly or quite to the base, in having no petioles over about 5 mm. long, and in

being more finely pubescent on the leaves. Although it has been my practice to use the subspecific category for intraspecific units having largely distinct ranges, I hesitate to do so in this case because so little is known about the distribution and range of variation of the plants concerned. I am therefore adopting the term variety.

AGASTACHE CUSICKII (Greenm.) Heller var. *typica* nom. nov. *Lophanthus Cusickii* Greenman, *Erythea* 7: 119. 1899. *Agastache Cusickii* Heller, *Muhlenbergia* 1: 59. 1904.

AGASTACHE CUSICKII (Greenm.) Heller var. *parva* var. nov. Planta 10–15 cm. alta, herbacea fere vel omnino ad basim, petiola ad 5 mm. longa, cetera similis var. *typicae*.

Type. On limestone outcrop 1 mile southeast of Double Springs summit, 8 miles northeast of Dickey, Custer County, Idaho, at 8600 feet elevation, 3200 (Missouri Botanical Garden; isotypes at University of Minnesota, Utah State Agricultural College and University of Idaho, Southern Branch).

Dr. Palmer Stockwell has recently published a revision of the genus *Chaenactis* (4). In the group surrounding *C. Douglasii* (Hook.) H. & A., he places considerable stress on the duration of the root, character of the caudex, and detailed structure of the pappus. *C. rubricaulis* Rydb., *C. ramosa* Stockwell, and *C. angustifolia* Greene are segregated and allowed to stand on these bases. In dry open places of the Transition and Canadian Life zones of central Idaho grows a perennial branching *Chaenactis* which would key in Stockwell's treatment to *C. ramosa* or *C. rubricaulis*. It is distinctive enough and constant enough to warrant some sort of segregation from typical *C. Douglasii*, but intergrades with the latter so much that it should not be accorded full specific rank and cannot be other than a variety of *Chaenactis Douglasii*. If the pappus characteristics stressed by Stockwell prove constant, it cannot be the same as *C. ramosa*, a plant of central Washington. To *C. rubricaulis*, of southern Oregon and the Sierra Nevada, it seems more similar, differing most noticeably in the pink or pinkish corollas. Also it is less woody at the base, and does not have the "leaves . . . mostly basal-rosulate," as does *C. rubricaulis*. Monographic reconsideration, which is beyond the scope of this paper, may show these differences to be inconsequential, but, in any case, the Idaho plants seem to be clearly a variety of *C. Douglasii*.

CHAENACTIS DOUGLASII (Hook.) Hook. & Arn. var. *typica* nom. nov. *Hymenopappus Douglasii* Hook. Fl. Bor. Am. 1: 316. 1834. *Chaenactis Douglasii* Hook. & Arn. Bot. Beechey Voy. 354. 1840.

CHAENACTIS DOUGLASII (Hook.) Hook. & Arn. var. *ramosior* var. nov. Planta perennis, in caules ramosos paucos vel plures

divisa quasi ab terrae superficie, corolla et interdum antherae plus minusve rubellae, cetera similis var. *typicae*.

Perennial, branching at or just below the surface of the ground into several freely branching stems 10–40 cm. high; corollas and sometimes anthers more or less pink-tinged; pappus scales half as long as the corolla; otherwise as the typical variety.

Type. Fine granitic talus along Salmon River, 2 or 3 miles below Stanley, Custer County, Idaho, altitude 6200 feet, July 5, 1941, 2890 (Missouri Botanical Garden; isotypes at University of Idaho, Southern Branch and Utah State Agricultural College).

Cotype. Dry gravelly hillside at Galena summit, Blaine County, altitude 8750 feet, July 31, 1941, 3250.

Collections number 2695 and 3279, both from Custer County, are fairly representative, but some specimens are somewhat suggestive of var. *typica*. Collection number 3076, from a dry gravelly hillside above Willow Creek, 4 miles northeast of Dickey, Custer County, at 7000 feet, differs in lacking the pink tint and being nearly simple at the base, but is strongly branching, and may be regarded as intermediate to var. *typica*.

Some plants which are noteworthy for various reasons, chiefly for not previously having been known to occur in Idaho, are grouped by counties and listed below.

Blaine County: *Bromus japonicus* Thunb. (3421); *Stipa californica* Merr. & Davy (3422); *Carex scopulorum* Holm (3641); *Carex suborbiculata* Mack. (2644, 2672); *Saxifraga occidentalis* Wats. (2592); *Thlaspi idahoense* Payson (2585); *Amelanchier polycarpa* Greene (= *A. glabra* Greene?) (2596); *Epilobium obcordatum* Gray (3729); *Navarratia divaricata* (Torr.) Greene (2661); *Cryptantha echinella* Greene (3518); *Aplopappus aberrans* (A. Nels.) Hall (3769).

Custer County: *Poa rupicola* Nash (2990); *Carex subnigricans* Stacey (!) (3389, 3413); *Carex suborbiculata* Mack (2771); *Lesquerella Cusickii* Jones (3178); *Artemisia annua* L. (3799); *Townsendia montana* Jones (3197).

Boise County: *Subularia aquatica* L. (3646); *Thlaspi idahoense* Payson (3623); *Aplopappus Greenei* Gray subsp. *typicus* Hall (3625).

University of Minnesota,
Minneapolis, Minnesota,
May, 1942.

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THE LEGITIMACY OF THALICTRUM POLYCARPUM WATS.

ARTHUR CRONQUIST

In a recent article in Madroño (7: 1-4. 1943), Croizat maintains that the name *Thalictrum polycarpum* Loret (1859), although illegitimate and not validly published, renders *T. polycarpum* Wats. (1879) illegitimate, as a later homonym. He cites article 61 of the Rules, in part, as follows: "Even if the earlier homonym is illegitimate, or is generally regarded as a synonym on taxonomic grounds, the later homonym must be rejected."

Croizat admits that *T. polycarpum* Loret was not validly published. The part of article 61 which he does not quote, states: "A name of a taxonomic group is illegitimate and must be rejected if it is a later homonym, that is, if it duplicates a name previously and *validly published* for a group of the same rank based on a different type." (Italics mine.) The Rules are clear enough; a name must be validly published if it is to prevent the later use of the same name for a different plant. To further clinch the case, article 19 states: "A name of a taxonomic group has no status under the Rules, and no claim to recognition by botanists, unless it is validly published."

It seems clear that the name *T. polycarpum* Loret, since it was not validly published, cannot illegitimize *T. polycarpum* Wats.

University of Minnesota,
Minneapolis, Minnesota,
February, 1943.

VALID AND LEGITIMATE NAMES—AND THALICTRUM POLYCARPUM S. WATS.

C. A. WEATHERBY

To devise a set of rules which shall deal adequately with the almost endlessly various nomenclatural situations which exist or may arise is an exceedingly difficult task. It is therefore not surprising that, in the eight years since the publication of the current Rules of Botanical Nomenclature, a number of cases have been brought to light which are not directly covered by the rules or in which the application of the rules is doubtful. It is not an unreasonable hope that, through the exercise of that faculty mis-called *common sense*, through carefully considered discussion of questions actually arising in the course of taxonomic investigation, through decisions by a competent tribunal and cautious amendment of the rules where really necessary, these doubtful points gradually can be made clear. Their solution has not been helped by much of the theoretical discussion of nomenclature for

its own sake published since 1935, especially when it raises illusory difficulties for the bewilderment of the unwary.

Unhappily, Dr. Croizat's discussion of the name of *Thalictrum polycarpum* S. Wats. (Madroño 7: 1-4. 1943), must be classed with those which obscure rather than elucidate their subject. There is no real ambiguity in the use of the terms valid and legitimate and their opposites in the rules. A valid name is one published according to the prescriptions of articles 36 to 45 and otherwise in accordance with the rules (art. 16, note). A valid name is *ipso facto* legitimate; that term, however, is reserved for requirements other than publication. An illegitimate name is one which, though validly published, fails to meet other requirements of the rules (arts. 60 to 69). A fully invalid name is like the last state of the wicked in Buddhist theology—it simply does not exist. Being, for nomenclatural purposes, non-existent, the rules pay no attention to it.

Any confusion which Dr. Croizat detects arises, not from the rules, but from his own unnecessary attempt to redefine the above terms. The first sentence of article 61, the most important for the present question, has entirely eluded him. It reads: "A name of a taxonomic group is illegitimate and must be rejected if it is a *later homonym*, that is if it duplicates a name previously and *validly published* [*italics here are mine*] for a group of the same rank based on a different type." That is, the earlier homonym must have been validly published in order to bring about rejection of the later one. According to the rule voted at Amsterdam, a provisional name is not validly published; therefore it cannot be a bar to the later independent use of the same name.

The rule as to provisional names was formulated in the course of debate at the Amsterdam Congress, as a substitute for a proposal to outlaw them originally made at the preceding Cambridge Congress and there referred to the Executive Committee (which took no action). As published in the Journal of Botany (74: 75. 1936), it carries no definition of *nomina provisoria* (invalid) and *nomina alternativa* (valid) and no adequate examples.¹ Until it is perfected there may be doubt as to whether a given name is provisional or not. Had Dr. Croizat argued that such doubt existed in regard to Loret's names and that it was therefore safer to employ Greene's name for the Californian *Thalictrum* rather than Watson's, he would have been on firmer, though still highly uncertain, ground and his argument would have been more to the point. For the status of Loret's names is, in the light of article 61, the only consideration of any importance in determining the correct name for the species. If *Thalictrum polycarpum* Loret is provisional, then *T. polycarpum* S. Wats. is the legitimate name

¹ The reference to the original proposal does not help; there the definition was drawn and the examples presumably selected to cover both kinds of names.

and must be used. If *T. polycarpum* Loret is validly published, then *T. polycarpum* Wats. becomes a later homonym and *T. ametrum* Greene (or some other synonym; I do not know the taxonomy) must be taken up.

In view of the imperfect elaboration of the rule as to provisional names, the only safe course seems to be to admit as validly published under it only names which conform closely to the example from de Wildeman given. He had a plant which he unreservedly accepted as a new species, but he was in doubt as to the genus to which he should refer it, and called it both *Cymbopogon Bequaerti* and *Andropogon Bequaerti*. According to the rule, both these names are validly published. But if de Wildeman had written: "I do not feel justified in describing this as a new species; but if I were to do so, I should call it either *Cymbopogon Bequaerti* or *Andropogon Bequaerti*"—that is, if he had not definitely accepted the species²—then, as I see it, both names would be provisional and not validly published.

The hypothetical quotation is very near what Loret actually did. On the above basis, then, *T. polycarpum* Loret is a provisional name, not validly published and incapable of functioning as an earlier homonym, and *T. polycarpum* S. Wats. is the correct name for the species.

Gray Herbarium, Harvard University,
February, 1943.

THE ANATOMY OF REDWOOD BARK

IRVING H. ISENBURG

This paper is one of a series originating from the laboratories of The Institute of Paper Chemistry, Appleton, Wisconsin, and covering a fundamental study of the botanical, chemical and other characteristics of the California redwood; this work has been sponsored by The Pacific Lumber Company, Scotia, California. The present paper is a portion of a botanical study made by the author at the Institute in 1939. Although considerable data have appeared in the literature on the anatomy of the wood of *Sequoia sempervirens* (see J. N. Mitchell, Jour. Forestry 34: 988-93. 1936 for discussion and list of references) the only published work on the anatomy of redwood bark seems to be that included in the article by Abbe and Crafts, who examined the phloem of white pine and other coniferous species (L. B. Abbe and A. S. Crafts, Bot. Gaz. 100: 695-722. 1939). Their studies

² On this point—the only definition of a provisional name we have—see Int. Bot. Congress. 1930. Nomenclature. Prop. Brit. Botanists 16 (art. 44); Rec. Synopt. 41 (art. 37 ter).

were apparently confined to the inner bark and stressed maturation of the sieve cells.

The bark of a merchantable redwood tree, *Sequoia sempervirens* (Lambert) Endlicher, is composed of secondary phloem, living and dead, and of periderm. The redwood is a thick-barked tree; the bark is sometimes as much as a foot thick but is usually much less. In external appearance it is reddish, deeply furrowed, and scaly. In transverse section the bark appears as two strikingly different colored rings—the very thin, whitish, inner one and the thicker, reddish-brown, outer one. The light-colored layer, which may have a pinkish tinge, rarely exceeds one quarter of an inch in thickness.

PRIMARY BODY

Although the primary bark tissues disappear early in the life of a redwood tree, a brief review of their structure seems to be in order before proceeding to a more detailed study of the secondary phloem. The primary body is self-sufficient and contains all the fundamental tissues and body parts. A cross section of a redwood stem at the end of the first growing season shows (pl. 6) the pith, primary xylem, cambium, primary phloem, cortex, and epidermis, as well as the secondary xylem and phloem. An accessory protective layer, the hypodermis, is located just beneath the epidermal layer. A few longitudinal resin canals are also evident in the cortex in plate 6.

The primary tissues lying outside the cambium are pushed outward by the development of secondary tissues. The increase in circumference to which these tissues must accommodate themselves quickly surpasses their ability to respond, with the result that, sooner or later, they are crushed or ruptured and killed by exposure, and especially by the stoppage of food and water supplies by the cork layers which develop within them. Obviously, the secondary phloem is very important functionally to the tree, because it soon replaces the primary phloem.

SECONDARY PHLOEM

The secondary phloem of redwood contains four types of cells—sieve cell, longitudinal parenchyma, fiber, and ray parenchyma (pl. 8).

The sieve cell is the cell characteristic of secondary phloem from the viewpoint both of structure and function. In some specimens of redwood bark examined, the sieve cells comprised the majority of the cells, both in the inner living and in the outer dead bark; in others, there occurred greater amounts of phloem parenchyma. Similar to other gymnosperms, the sieve cell elements are not arranged in series, end to end, forming definite conducting lines, but are separate and distinct. The sieve plates are scattered irregularly on the radial walls of the sieve cell ele-

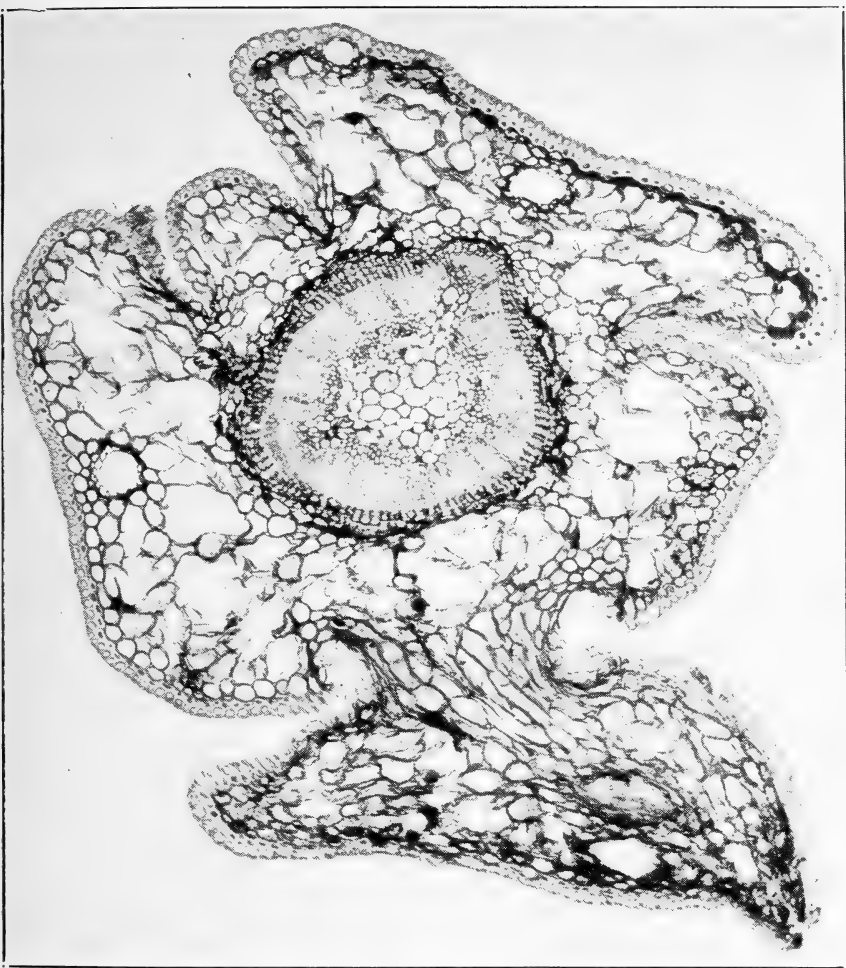


PLATE 6. SEQUOIA SEMPERVIRENS. Cross section of one year old stem.
× 73.

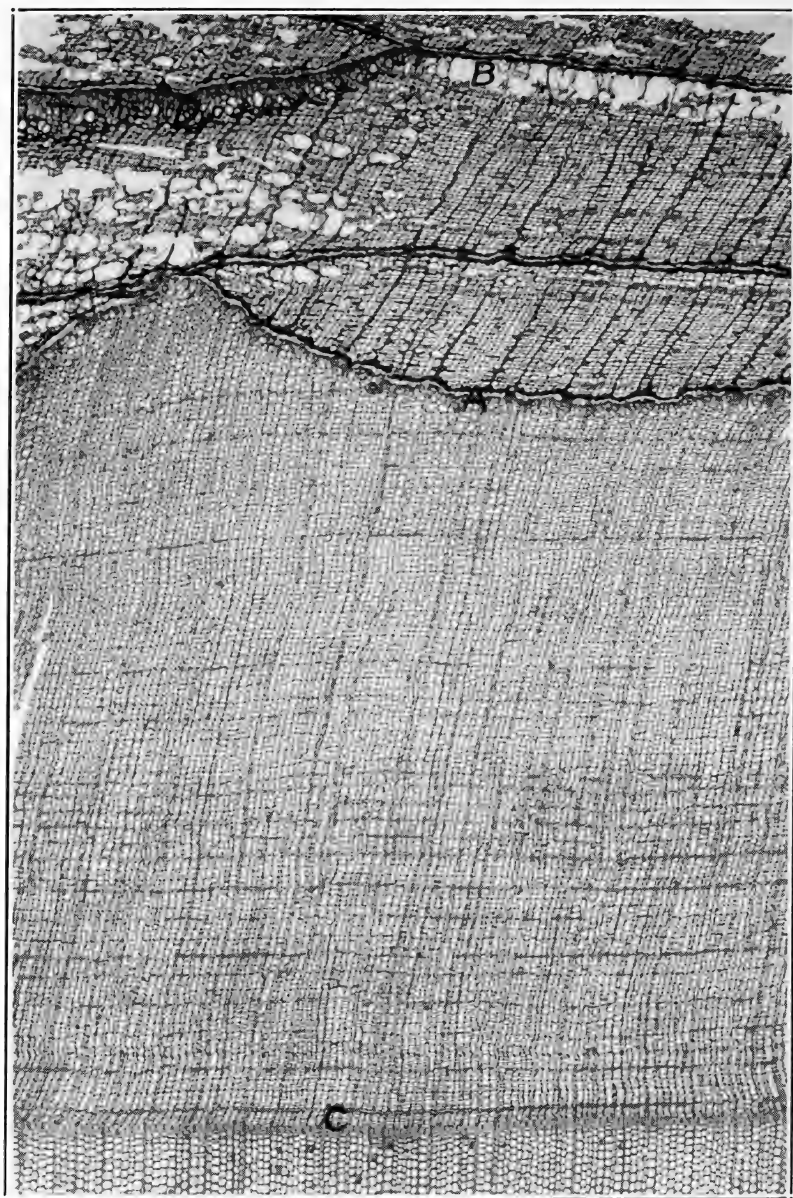


PLATE 7. *SEQUOIA SEMPERVIRENS*. Cross section of inner and small part of outer bark. $\times 20$. A, last-formed periderm; B, dilated phloem parenchyma; C, cambium; D, "reinforced" area.

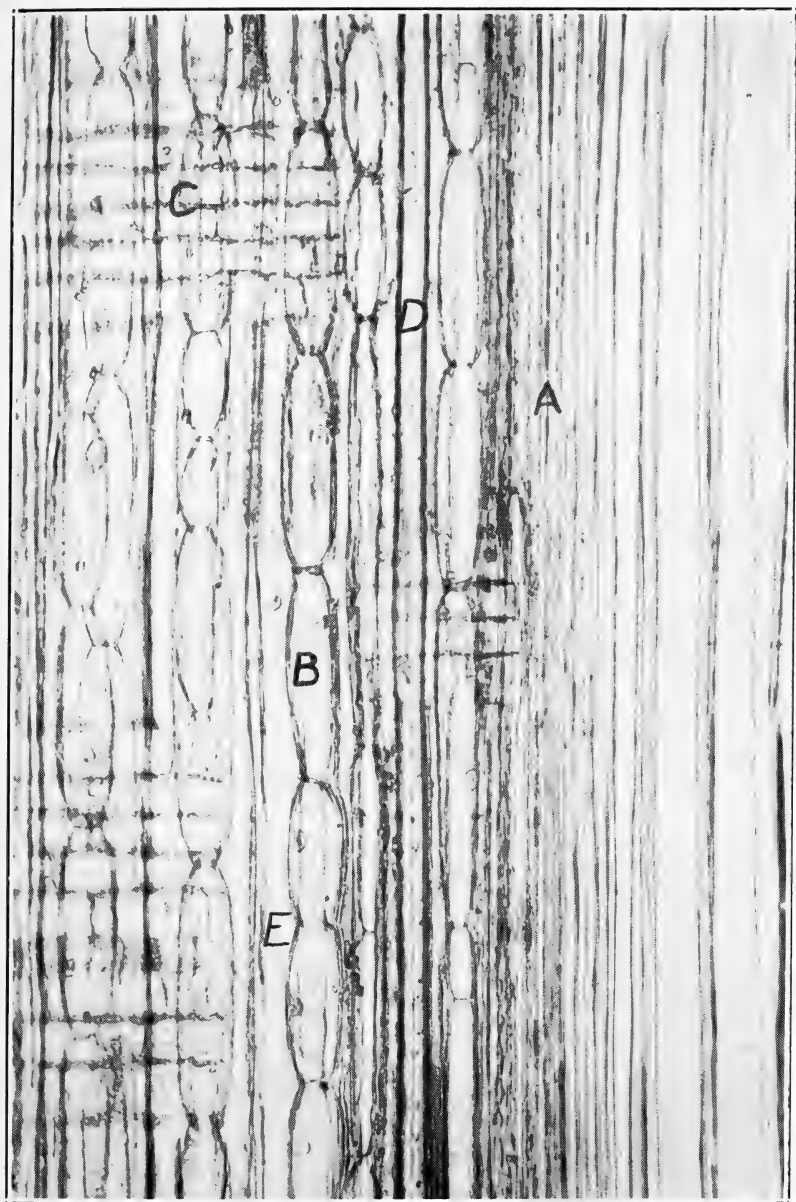


PLATE 8. *SEQUOIA SEMPERVIRENS*. Radial section of inner bark and sapwood. $\times 200$. A, cambium; B, phloem parenchyma; C, ray; D, fiber; E, sieve cell.

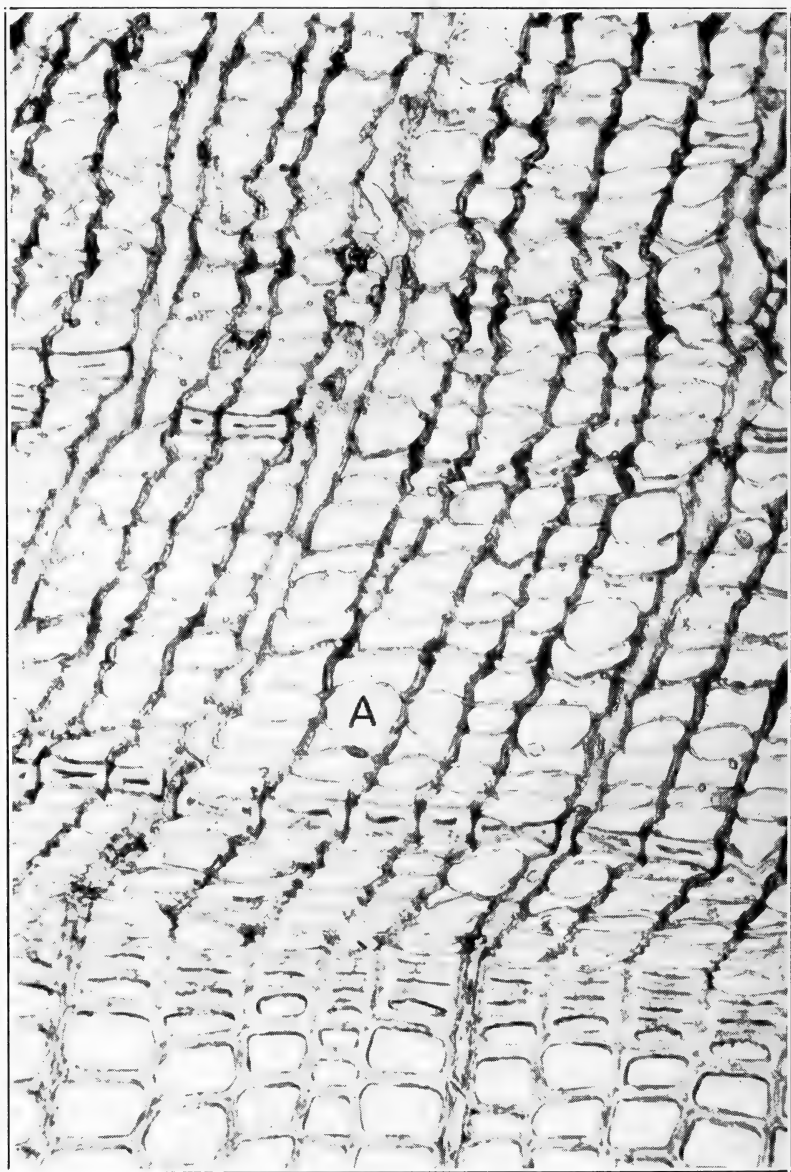


PLATE 9. *SEQUOIA SEMPERVIRENS*. Cross section of inner bark. $\times 200$. A, phloem parenchyma.

ment; their diameter is only slightly less than that of the sieve cell. Painsstaking work by Abbe and Crafts has revealed many interesting details in the living sieve cells in *Sequoia sempervirens* and other coniferous species, especially *Pinus strobus*.

The phloem parenchyma cells are rectangular, or more or less rounded, in cross section because of bulging tangential walls (pl. 9, A), with the larger dimension tangential. The height of the cell is several times greater than either transverse dimension. When the parenchyma cells appear rectangular in transverse section, it is impossible to distinguish them from sieve cells. It is very easy, of course, to separate parenchyma and sieve cells in either longitudinal plane because of their great difference in length and also because of the presence of sieve plates in the walls of the latter. The average length of phloem parenchyma cells is 180 microns, ranging from 110 to 300 microns.

The phloem fibers are arranged in tangential uniseriate rows which occur rather regularly (pl. 10). These fibers are of economic interest. However, although the bark of the redwood tree is termed fibrous, it does not, unfortunately, contain a very large percentage of fibers by weight. The frequency of formation of these uniseriate rows of fibers cannot be determined in older sections of bark because of the formation of periderm and the sloughing of outer dead bark. Examination of several smaller stems suggests that approximately one row of phloem fibers is formed each year, at least during the first ten years. Later they appear to be formed less frequently. It seems more probable, however, that the number of rows and the dimensions of the fibers are dependent upon environmental factors. The average length of more than 300 fibers was 6.73 mm., ranging from 3.0 to 9.6 mm., with a standard deviation of ± 0.14 mm. The average tangential diameter was 46 microns and the average radial diameter was 18 microns. As might be expected, the individual data covered a much greater range in radial than in tangential dimension. The fibers have a very thick wall and a slit-like lumen. Simple pits occur on the radial walls.

The phloem ray consists entirely of parenchyma cells. These rays are usually uniseriate, although not infrequently some biseriate rays occur. In height they varied from one to many (about 27) cells, or approximately 700 microns. The average length of the ray cell was 130 microns, ranging from 80 to 250 microns. There were approximately four rays per millimeter tangentially, as measured on the cross section. Abbe and Crafts have reported relatively fewer albuminous cells in the phloem rays of redwood than in white pine. In the present study short rows of erect marginal cells were found very close to the cambium in a few of the phloem rays.

The tissues of the secondary phloem of redwood appear to be arranged in definite tangential bands (pl. 7), as a result of

the rather regular occurrence of the fibers in tangential uniseriate rows. However, these ring-like bands do not have definite seasonal limits as do those of the secondary xylem, because there is no distinction between the phloem cells formed in the early spring and those of the late summer comparable to the difference between springwood and summerwood.

PERIDERM

The last-formed periderm is located at the boundary of the inner living bark and the outer dead bark (pls. 7, 10, and 16). Only a few rows of cork cells are formed by the phellogen. There are an approximately equal number of phelloderm cells formed. The cells constituting the phellem, commonly known as cork cells, are uniform in shape; in this respect they resemble the cork cambium cells from which they originated (pls. 12, B, and 13, B). The cork cell is filled, at least partially, with a dark reddish-brown alkali-soluble material designated as acid-lignin; this material also occurs within the ray cells of the outer bark but otherwise appears to be deposited as a thin coating on the walls of cells in the outer dead bark. The mature cork cells are non-living and usually without pits. Phelloderm cells are living and are arranged in definite radial rows (pls. 12, C, and 13, C). A phellogen in the redwood tree functions for only a brief period of time; its component cells then mature to form one of the derived cells, but they do not necessarily have colored contents. The formation of each periderm layer shuts off all outer tissues from the food and water supply; thus, soon after the initiation of a layer, all outer tissues die. Lenticels occur in the periderm layers of redwood bark just as they do in the barks of other species.

VARIATION IN THE BARK

In order to study variation in bark structure, microsections from many sources were examined but most attention was given to a piece of bark about 7 inches thick. Small blocks were taken at the boundary of the inner and outer bark, and in the outer bark at points which were 1.5, 3, 4, 5, and 6.5 inches from the cambium. Because of the brittleness of the outer bark, it was necessary to embed the samples in celloidin before sections could be cut. Unfortunately, even this preparation did not prevent tears so that perfect, untorn sections were not obtainable.

A study of the microsections revealed a marked structural difference between the inner bark and the outer bark (pls. 9, 10, 14, and 16) but little variation among parts of the outer bark in this series (pls. 15 and 17 are representative). The most noticeable of these differences between the inner and outer bark are:

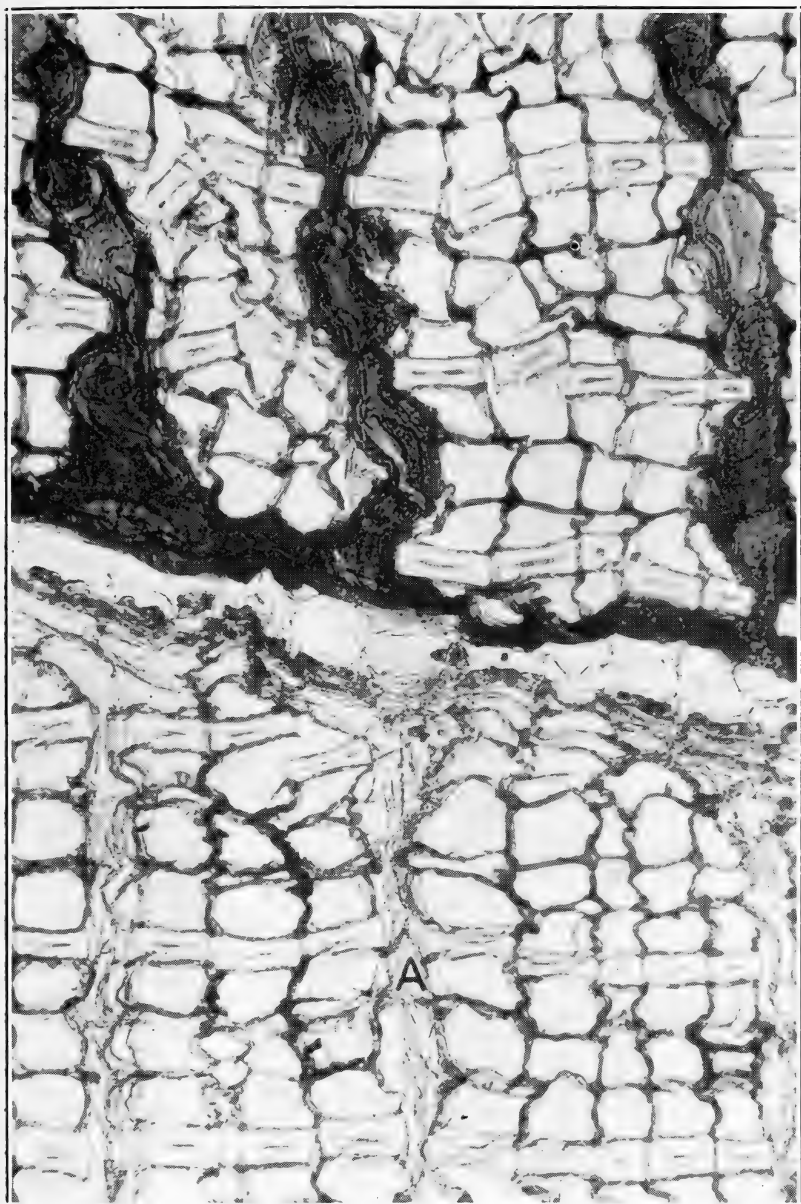


PLATE 10. *SEQUOIA SEMPERVIRENS*. Cross section of inner and outer bark boundary. $\times 200$. A, ray.

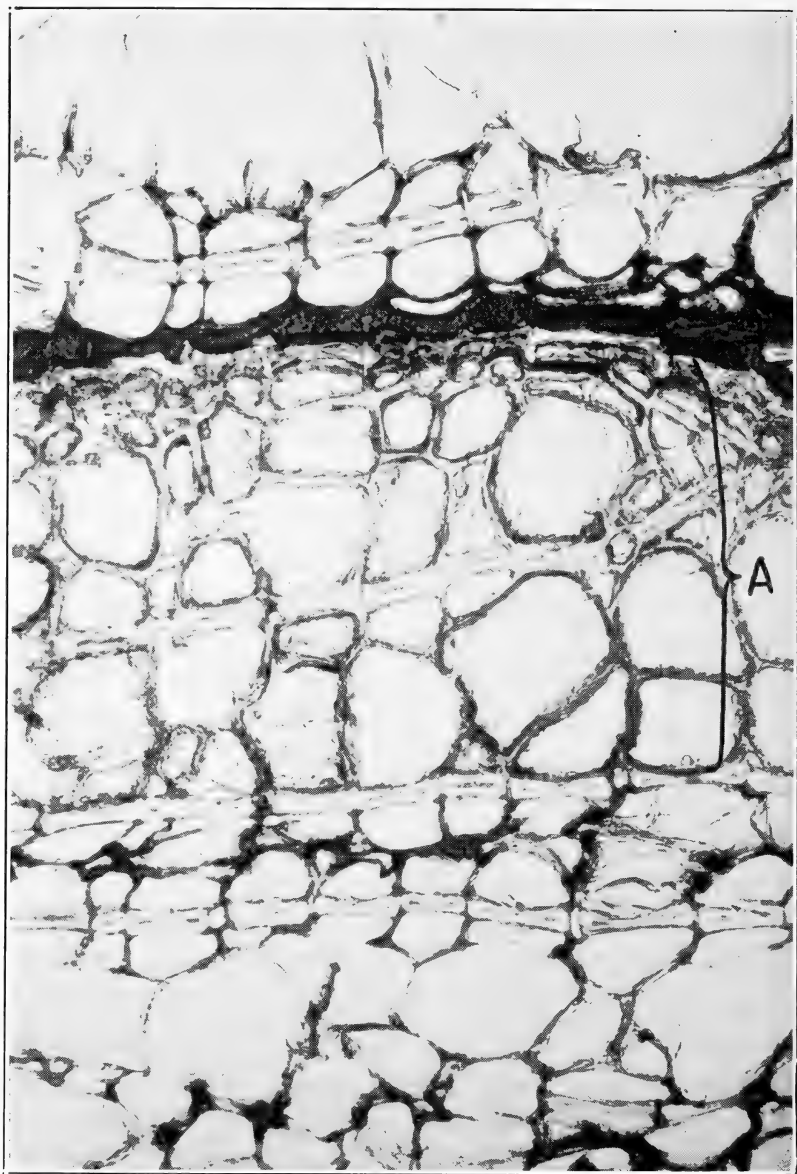


PLATE 11. *SEQUOIA SEMPERVIRENS*. Cross section of "reinforced" area in outer bark. $\times 200$. A, "reinforced" area.

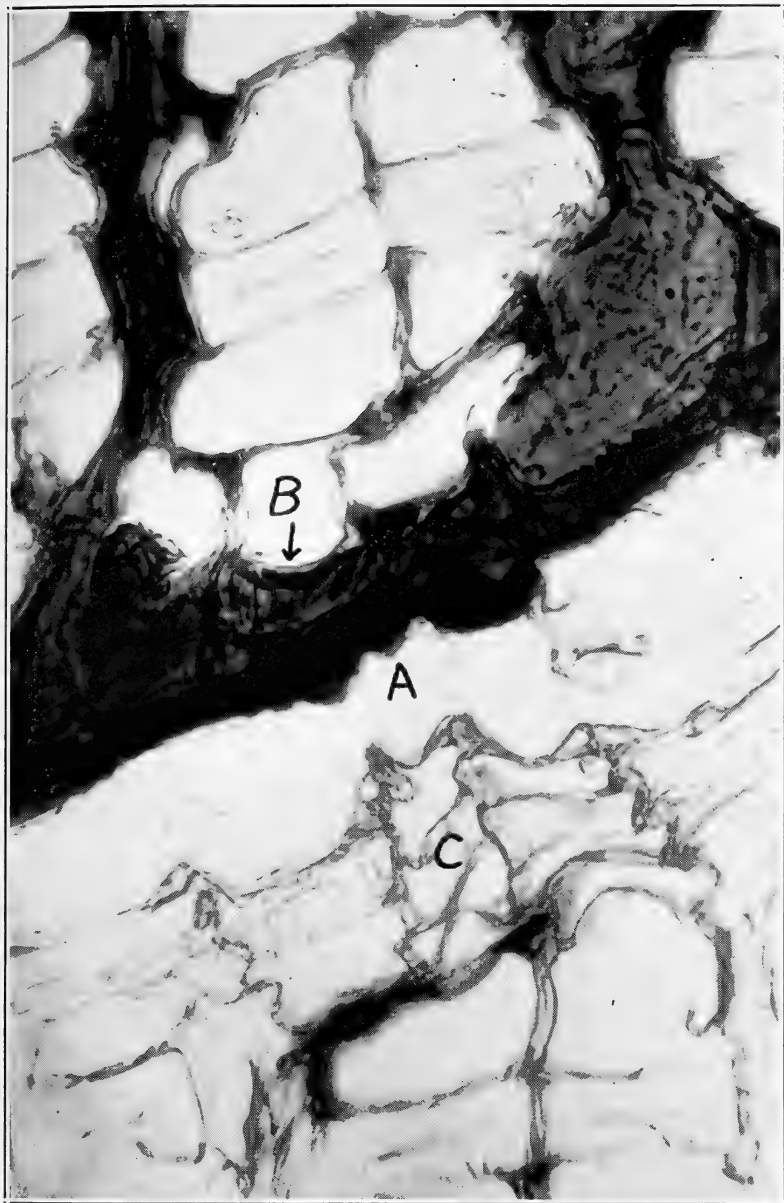


PLATE 12. *SEQUOIA SEMPERVIRENS*. Cross section of last-formed periderm.
× 500. A, phellogen; B, phellem; C, phelloderm.

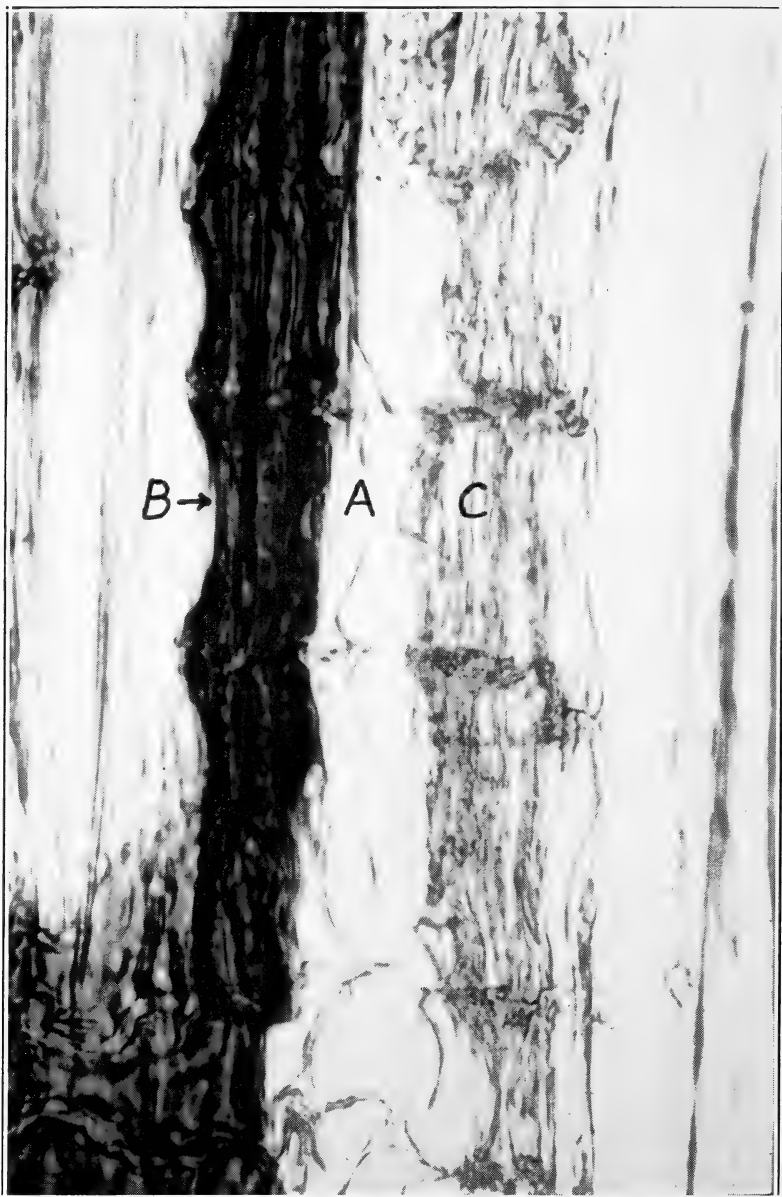


PLATE 13. *SEQUOIA SEMPERVIRENS*. Radial section of last-formed periderm. $\times 500$. A, phellogen; B, phellem; C, phelloderm.

(1) the swelling of some of the ray parenchyma cells (pl. 10), with occasional increase in the number of cells in the width of the rays; (2) the increase in radial diameter of some of the phloem parenchyma cells (pls. 14, A, and 16, A); (3) the formation of "reinforced" areas of the thicker-walled parenchyma cells inside the periderm of outer bark (pls. 14, B, and 16, B); and (4) the presence of old periderms (pl. 18).

The lateral expansion of the ray cells may be due to the fact that they probably remain alive until the most recent periderm completely seals off the shell, thus forcing back some of the thin-walled longitudinal cells. It can be seen in many of the photomicrographs (e.g., pl. 10) that, where the ray cells are in contact with the thick-walled fibers, they do not dilate. The increase in the width in cells of the phloem ray may be due to the need for peripheral expansion when the stem increases its diameter. Such an increase may also occur in the outer part of the inner bark.

Not all phloem parenchyma cells show an increase in radial diameter, nor do all the specimens exhibit this phenomenon (e.g., pl. 18). The cause of this dilation is unknown. It may be a response to excessive increase in the circumference of the stem, or perhaps it is a mechanism for abscission of the old bark.

The so-called "reinforced" areas of thick-walled cells, found frequently internally adjacent to the phellogen in the outer bark, are not present in all specimens of redwood bark, nor are they located regularly in the same cross section of bark. There does appear to be a relationship between the dilated phloem parenchyma cells and the thicker-walled cells of these "reinforced" areas, because both phenomena are usually found close together (compare pls. 7, 14, 16, and 18).

The cells of these "reinforced" areas appear to be phloem parenchyma cells, which have dilated somewhat and thickened their walls. The walls of these cells, although thicker than those of the sieve tubes and phloem parenchyma, are not as thick as those of the phloem fibers (pl. 11). When treated with 72 per cent sulfuric acid, these walls appear to swell.

The location of these cells suggests phelloderm, although several facts refute this, namely: (1) they are not of universal occurrence in redwood bark and, even in the sections where they do occur, their distribution and amount are not uniform; (2) usually there are many more cells than normally occur in redwood phelloderm; (3) they are not found inside the most recent phellogen layer; (4) uniseriate rows of phloem fibers are located within these "reinforced" areas; and (5) close examination reveals crushed and torn fragments of sieve tubes clinging to the phloem fibers. The exact classification of these cells is difficult, but they appear to be a modified parenchyma cell.

The phloem fibers develop a short distance from the cambium (pl. 9), and the tangential uniseriate rows are spaced rather

evenly throughout the bark with from two to five rows of cells between the rows of fibers (pls. 10 and 18). Considerable variation is evident, but usually a row of sieve tubes is found on each side of the fiber with a row of phloem parenchyma between the sieve tubes (pl. 16). This same standard pattern has been reported in the secondary phloem of redwood and incense cedar by Abbe and Crafts.

Fiber length measurements were made at various distances from the cambium. The following values, each representing an average of 30 measurements, were obtained: inner bark, 7.1 mm.; outer bark (1.5 in.¹), 6.8 mm.; outer bark (3 in.), 6.6 mm.; outer bark (4 in.), 6.6 mm.; outer bark (5 in.), 6.4 mm.; and outer bark (6.5 in.), 6.65 mm. These measurements were made on unbroken fibers isolated by the nitric acid-potassium chlorate maceration method. From the data, it must be concluded that there is no significant difference in length of fibers with increased distance from the cambium.

Calculations were made to determine the relative volume which the phloem fibers occupy in the bark. The following values were obtained: inner bark, 18.7 per cent; outer bark (0.25 in.¹), 5.6 per cent; outer bark (1.5 in.), 6.7 per cent; outer bark (3 in.), 4.8 per cent; outer bark (4 in.), 5.9 per cent; and outer bark (5.25 in.), 4.9 per cent. The greatest difference is obviously between the inner bark and the outer bark, and is undoubtedly due to an increased radial diameter of some of the phloem parenchyma. A specimen of outer bark (a short distance from the inner bark), which showed no dilation, had 10.9 per cent fiber, whereas the adjacent inner bark had only 12.0 per cent as compared with 18.7 per cent previously observed for inner bark. These values are all based on volume. One might expect the percentages by weight to be higher but to show little variation in the outer bark. The calculation of weight percentages is complicated by the deposition of extraneous matter and parenchyma cell expansion. The volume difference between the inner bark and outer bark might disappear on a weight basis, as the weight of extraneous material might balance increased air space caused by cell expansion. No weight percentages were attempted.

MICROCHEMISTRY

The striking difference in color between the outer and inner bark of redwood is the result of the deposition of a reddish-brown substance. Although this coloring matter is conspicuous in the ray cells and the cells of the periderm, it is deposited on all cell walls. Microchemical tests were made to determine the nature of this material. It was found that the color could not be removed by a three-hour extraction with hot alcohol on a steam

¹ Distance from the cambium layer.

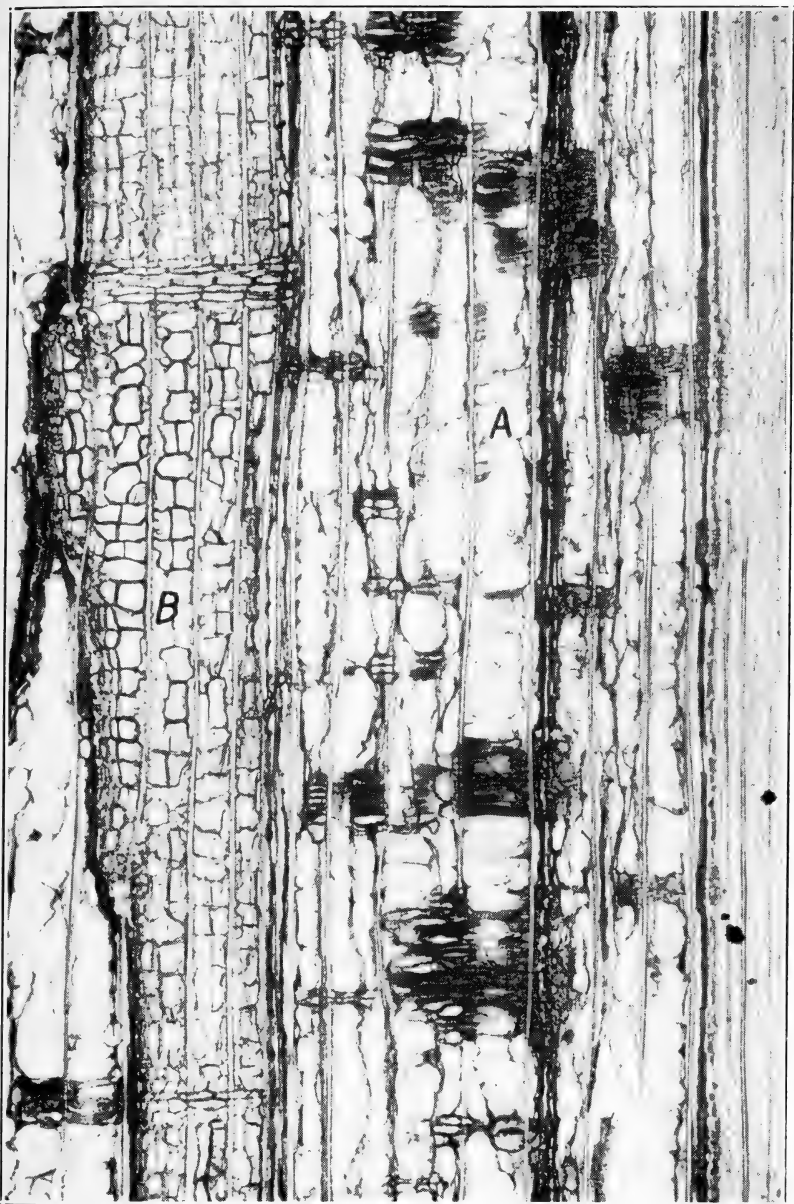


PLATE 14. *SEQUOIA SEMPERVIRENS*. Radial section of outer and small part of inner bark. $\times 30$. A, dilated phloem parenchyma; B, "reinforced" area.

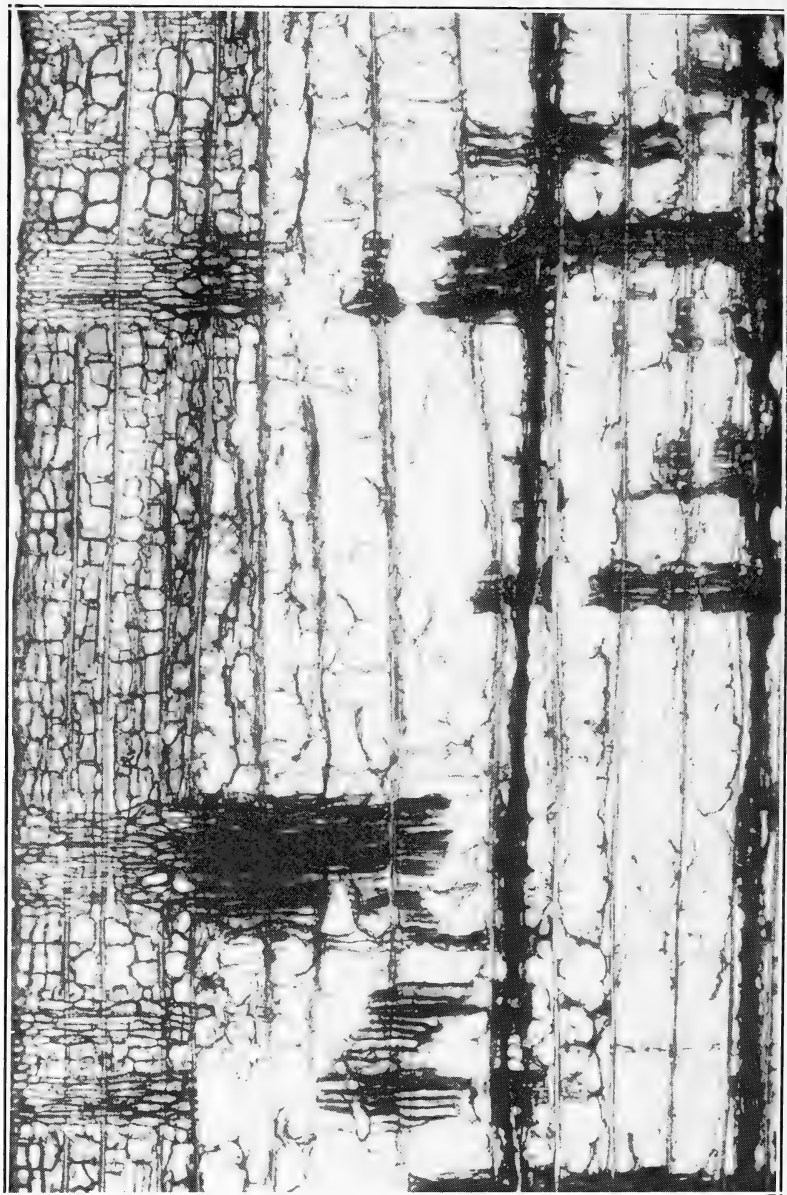


PLATE 15. *SEQUOIA SEMPERVIRENS*. Radial section of outer bark, 1.5 inches from the cambium. $\times 30$.

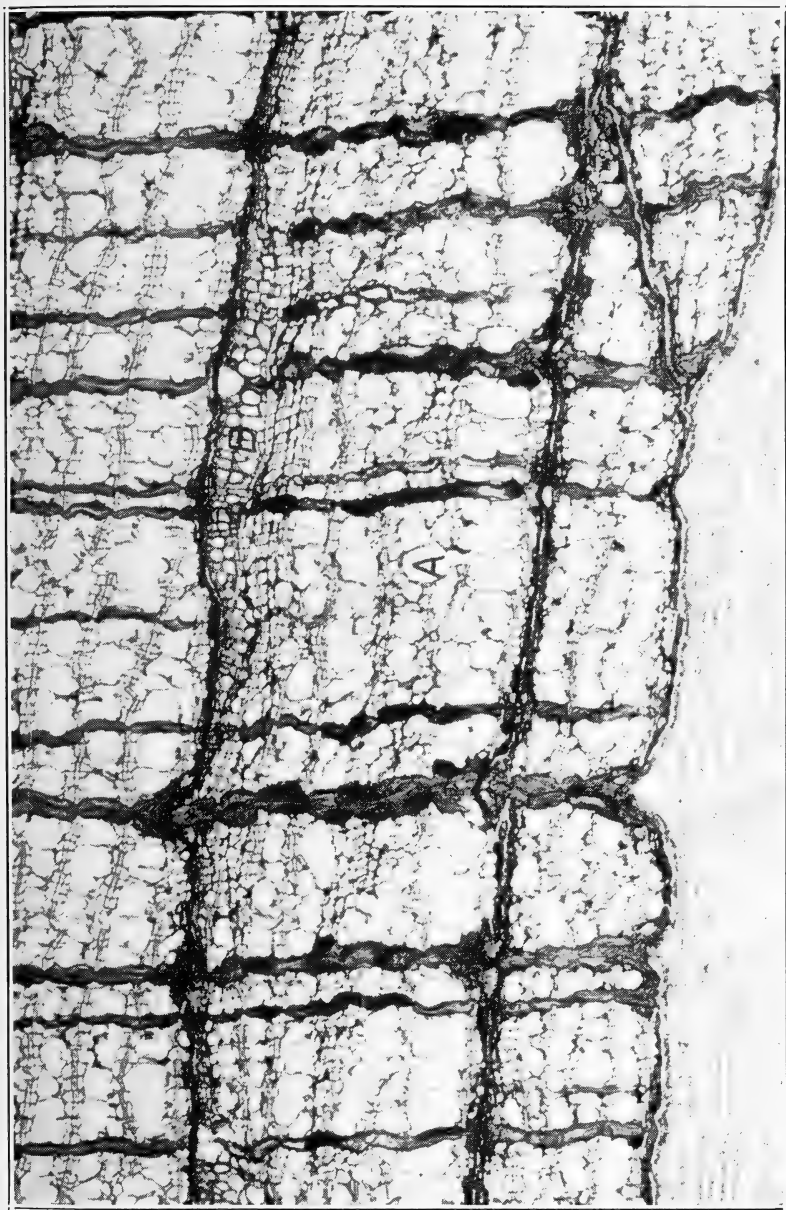


PLATE 16. *Scaevola sempervirens*. Cross section of outer and small part of inner bark. $\times 30$. A, dilated phloem parenchyma; B, "reinforced" area.

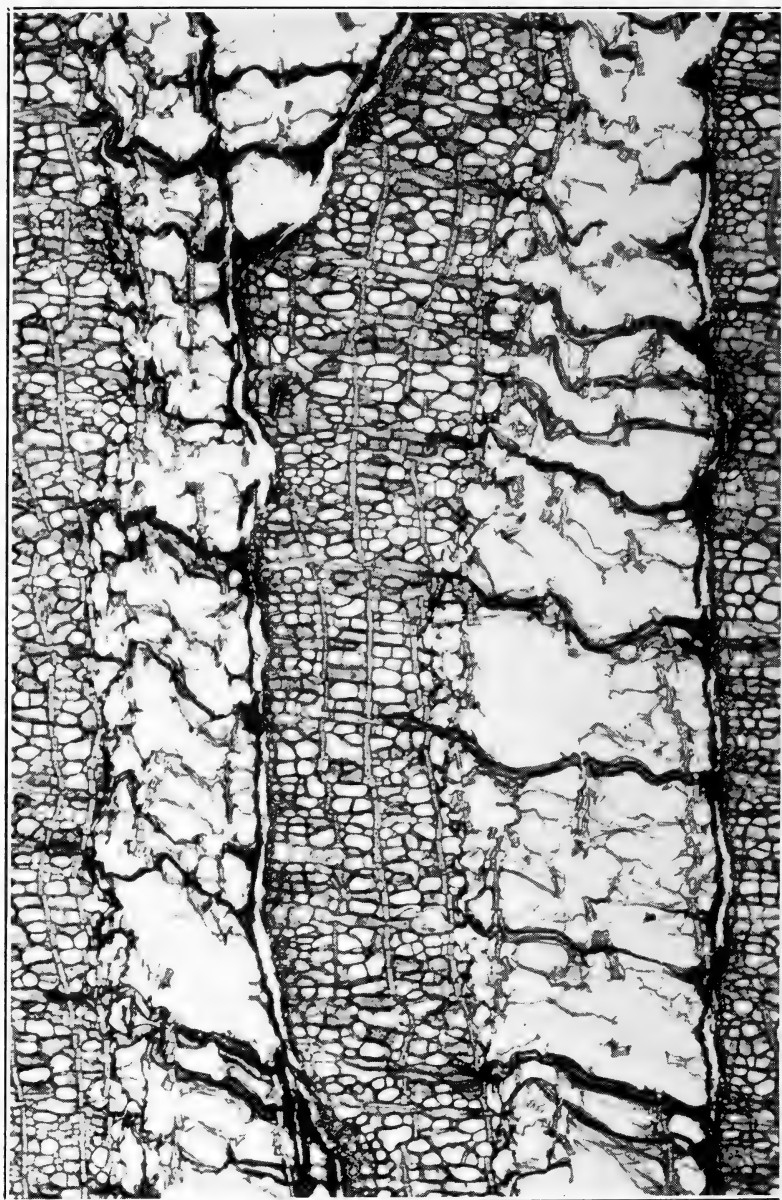


PLATE 17. *SEQUOIA SEMPERVIRENS*. Cross section of outer bark, five inches from the cambium. $\times 30$.

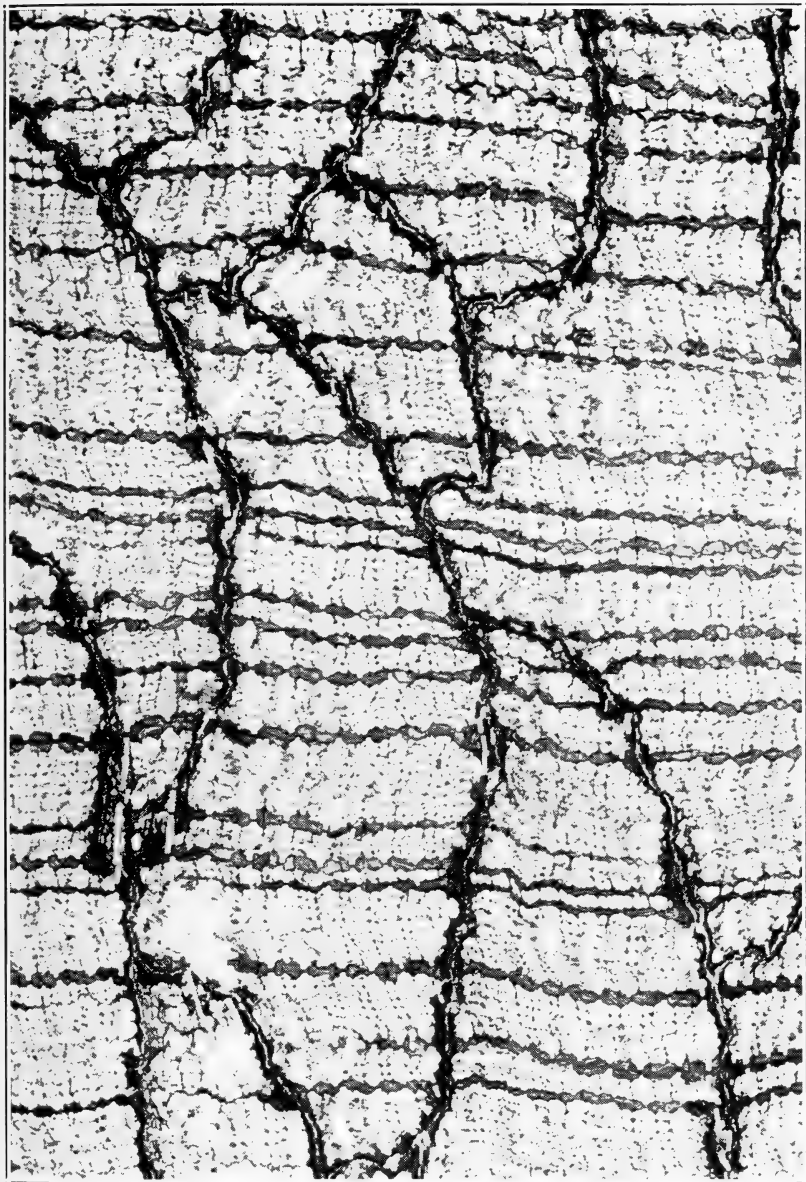


PLATE 18. *SEQUOIA SEMPERVIRENS*. Cross section of outer bark. $\times 30$.

bath or by a five-hour extraction with hot acidulated alcohol (3 per cent glacial acetic acid) on a steam bath. Treatment of the sections with 72 per cent sulfuric acid caused the yellow-colored phloem fibers to turn green and swell, eventually turning lavender but remaining as large balloon-like bodies and dissolving only partially. The contact with concentrated acid darkens the reddish-brown deposit in the ray cells and periderm cells, but otherwise it is not visibly affected. Thus, in a lignin determination this material would be insoluble and, hence, would be determined as lignin. Extraction with cold 1 per cent NaOH for several days removes a considerable portion of the coloring matter; the same effect can be obtained within a few hours by extraction on a steam bath. If the yellow-colored section remaining after alkali extraction is treated with 72 per cent sulfuric acid, much of the structure disappears; however, the fibers, although greatly swollen, remain intact. The fibers are largely cellulose, but contain some lignin, as well as a small amount of coloring matter. An extended discussion of the chemical composition of redwood bark will appear in a further publication.

The Institute of Paper Chemistry,
Appleton, Wisconsin,
May, 1943.

WILLIAM ALBERT SETCHELL

With the death of William Albert Setchell the botanical profession mourns the loss not only of a great algologist but also of one of its outstanding personalities and of a great and effective humanitarian. The details of his life have been amply treated by others (Goodspeed, T. H., William Albert Setchell, in *Essays in Geobotany in Honor of William Albert Setchell*, University of California Press, Berkeley, 1936). It will suffice here to state that he was born on April 15, 1864, was educated at Yale and at Harvard where he was a fellow and a student of Farlow. Subsequently he served as Assistant Professor at Yale and in 1895 came to the University of California as Professor of Botany retiring as Professor Emeritus in 1935. He died at his home in Berkeley, California, on April 5, 1943, just a few days before his seventy-ninth birthday.

A voluminous bibliography attests his activity in the field of algology. Much of this work was done in cooperation with the late Dr. Nathaniel Lyon Gardner with whom he built up one of the outstanding algological herbaria and libraries of the world, now deposited at the University of California at Berkeley. Together they attempted to complete a comprehensive treatment of the marine algae of the Pacific Coast of North America, of which all but that dealing with the red algae has been published. The

latter was left largely in rough manuscript form. His interests, however, encompassed much more than the algae. His writings and those of his students involve the fungi, bryophytes and some of the flowering plants as well. It was Setchell who initiated and inspired the investigations on tobacco so ably furthered by Clausen, Goodspeed, and the late Dr. Priscilla Avery.

He travelled widely over the world and collected much from diverse sources, bringing home not only specimens which are deposited in the Herbarium of the University of California, but vivid accounts of unusual plants, botanists, fellow travellers and an infinite number of personal anecdotes that delighted all who were fortunate enough to hear him.

To the perennial stream of students that flow through a large university he was a source of inspiration and wise counsel. The needy student was one of his primary concerns; he gave freely of his time and resources—often financing the entire cost for students who became ill and required hospitalization. Sometimes this was accomplished anonymously and at other times directly. When repayment was offered he would reply, "You had better keep it so that you may be able to do the same for somebody else." The gifted student was his special delight. He enjoyed provoking him into argument and never lost an opportunity to trip him. If he could lead him into making a rash statement, the student was never permitted to forget it. Until the day of his death, Professor Setchell was continually surrounded by youth to whom he was a genial host and for whose entertainment he provided the best in music and literature and always a subject for argument. He spoke of these associates as his "nephews" and a few "nieces"; they are to be found the world over and are of several races. All of them knew him fondly as "Uncle Bill" and all of them know each other, if not personally, at least by their reputation as to their ability to argue.

Professor Setchell loved words; he was at his best in an argument with strong opposition where he would let loose such a flow of brilliant terminology that his opponent was often baffled. Once an eminent geologist came in and settled in a chair, utterly exhausted. He remarked, "I have just come from an argument with Setchell. We were discussing the origin and structure of atolls. So long as he used words that I understood I had the better of the argument. Soon, however, he began using words that I had never heard before, presumably terms in my own field. I simply had to back out!" In most commonplace discussions Setchell would make free use of Greek or Latin, or perhaps he could express his idea better with a German word or a chance Maori term picked up in his travels. They were all in his vocabulary ready to be used where they would be most effective.

In teaching he had developed the technique of the showman

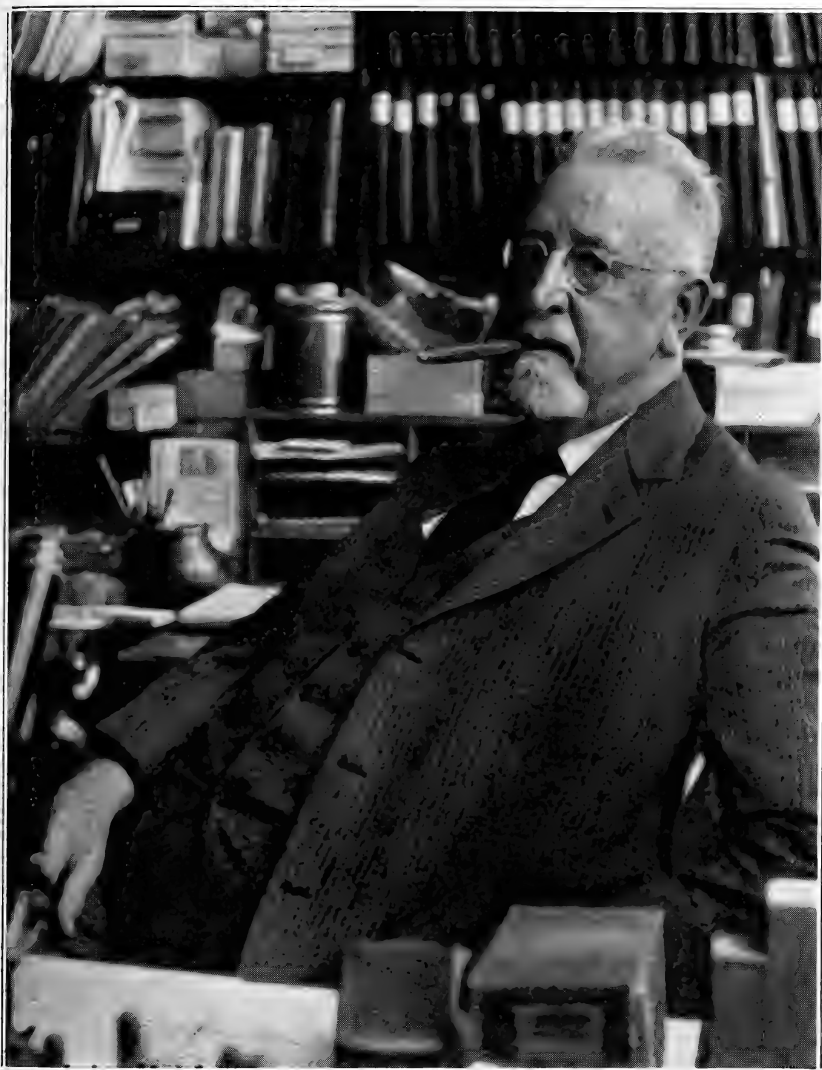


PLATE 19. WILLIAM ALBERT SETCHELL, 1936.

and his lectures in plant geography, especially those dealing with plant dispersal and dispersal mechanisms, were replete with demonstrations that were both highly instructive and entertaining. He had gathered great quantities of material for these lectures during his world travels. The lecture room was always adorned with large poster-like charts, illustrations or maps all attractively done in color. His lectures were rich in anecdotes of personal experiences vividly told. He was especially fond of giving a ludicrous account of himself—a large man with umbrella in hand being carried through the forest by diminutive natives, all the while booming out instructions to the native collectors as to what to collect and how to prepare it. Needless to say his lectures were always well attended.

He was a man of outstanding personality and had the habit of speaking his mind honestly, freely, and richly. Naturally there were those who found this uncomfortable. There was no room in his heart for picayunishness, personal animosity, disloyalty or intrigue; however, he suffered deeply but forgivingly of these traits in the hearts of others.

During the forty-eight years that Dr. Setchell was associated with the University of California, he saw and helped it develop from a young western school to one of the great state universities of this country. He was active in the life of the University and was one of its important figures. In 1931 his colleagues honored him with the Faculty Research Lectureship. With his death, students and associates have lost another of the contacts with classicists of the past.—HERBERT L. MASON.

REVIEWS

Studies of Evaporation and Transpiration Under Controlled Conditions. By EMMETT MARTIN. Carnegie Institution, Washington, Publ. 550. Pp. 1-48. 1943. Printed by offset.

The phenomenon of transpiration has justly commanded the attention of botanists, many of whom have attempted to get an index which would be useful in judging the habitat. The author of this work has carefully measured the transpirational loss of water from *Helianthus* and from *Ambrosia* for the purpose of determining its correspondence with evaporation from imbibed non-living surfaces. Many of his experiments employed small potted plants in special chambers though certain out-door comparisons were made at Santa Barbara, California, and at or near Colorado Springs, Colorado.

The resistance of the plant to water losses was more than once demonstrated by the work. For example, the relation between the rate of transpiration and relative humidity was approximately linear for young plants, but the rates of transpiration of older

plants were less than for younger ones at temperatures of 27° and 38° C.; though age seemed to make no difference at 49° C. Apparently the author overlooked the careful work on age and transpirational losses conducted by Bartholomew.

Records obtained from inserted thermocouples showed that a leaf exposed to radiation equivalent to that of noon sunlight may still maintain an internal temperature lower than that of the surrounding air. Transpiration reduced the temperature of the leaves 10° C. or less. At higher leaf temperatures the depression of the temperature of the leaf below the air decreased, probably due to the increased permeability of the cuticle and epidermal cell walls to water.

The regulatory power of stomata of *Helianthus* decreased as the air temperatures went up from 27° to 49° C. as shown by an increase in the ratios of night-time to daytime transpiration rates though the possibility of injury at 49° C. appears to have been disregarded.—H. S. REED, Department of Botany, University of California, Berkeley.

Systematics and the Origin of Species from the Viewpoint of a Zoologist. By ERNST MAYR. Pp. xiv + 334. Columbia University Press, New York. 1942. \$4.00.

This important work might better have been entitled "The Origin of Species [Microevolution] and [the Application of this Concept to] Systematics," for one does not have to read many pages before he discovers that traditional descriptive systematics has contributed very little to the discussion aside from the mechanics of nomenclature. The subject is approached from the broad viewpoint of a general biologist who not only understands the principles of genetics, ecology, morphology, physiology, and geographical distribution, but who is able to apply these to the problems of systematics. The result is a sound and pleasing philosophy of the nature of systematic units which seems to meet the requirements of the evidence from each of these diverse approaches.

As a specialist in one of the most highly developed branches of systematic biology (ornithology), Dr. Mayr is eminently well qualified to write on the subject of the origin of species and systematics. The biological array is so vast that it is only by the intensive study of a limited group that one may gain an insight into the forces which must govern the entire assemblage of groups. With a worldwide representation of only 8500 species (comparable in number to the "good" species of angiosperms indigenous to the western United States, but incomparably better known), the birds offer unusually favorable material for the formulation of biological principles. The systematic botanist may find many of Dr. Mayr's illustrative examples unfamiliar, but often he will be

able to supply similar examples from his experience with plant species.

Dr. Mayr conceives a species as a dynamic unit. "Species are groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups [p. 120]." As such, the species is a natural and an evolutionary unit, but it is not necessarily morphologically uniform. As a matter of fact, morphological uniformity is not a characteristic of most such species. The acceptance of this concept of polytypic species disposes of a difficulty against which cataloging systematists have been struggling for years. Whether each distinguishable geographical variant should be described and named as a subspecies (even if only 75 per cent of its individuals are determinable!) as is the practice of the ornithologist, or nomenclatorially ignored as is the preference of most systematic botanists is a question upon which there will continue to be diversity of opinion. The recognition of named geographical subspecies by the ornithologist is a compromise between the "lumpers" and the "splitters" among the taxonomists of the morphological school. To impose this compromise on groups which have never been split consistently into the smallest elements which could be distinguished even part of the time would not in the opinion of the reviewer simplify the classification of those groups. It may be sufficient to understand that most biological species do vary geographically.

The suggestion that the microgeographic races (jordanons) among plants do not have an exact homologue among animals is probably incorrect. This error possibly is due to a failure to realize the total magnitude of the barrier to free interbreeding imposed by immotility and habitat requirements. Microgeographic races among plants are the expression of genetic isolation of the same magnitude and sampling errors of the same kind as result in geographical subspecies among animals. They are equally distinct. If Dr. Mayr's criterion of a geographical subspecies is that it be regional rather than local, he may find such phenomena among those plants which have overcome the barrier of distance through the development of wind pollination or of highly effective mechanisms of seed dispersal.

Although he defines a species as consisting of "actually or potentially interbreeding natural populations," Dr. Mayr points out that many unquestionably distinct species are able to interbreed when brought together experimentally. Barriers which ordinarily would prevent interbreeding are often ineffective under artificial conditions. The important point is not whether two entities can interbreed or not, but whether or not they actually have done so in nature to the extent that their distinctive characteristics have become obscure. The existence of natural hybridization between species and even genera is freely admitted,

and criteria for the recognition of such secondary intergradation between distinct entities are clearly presented.

Genera are believed to be natural and monophyletic groups of species, although the exact size and content of a particular genus must necessarily be governed by taxonomic convenience and the preference of the individual systematist. Thus, unlike species, genera in different groups may not necessarily be comparable units. Among the birds, for instance, there are recognized at the present time some 2600 genera which average 3.27 species each. Dr. Mayr would consider "an average of 5 species per genus . . . definitely preferable to the present ratio." Genera of this small size would scarcely be advocated by the most extreme "splitters" among the plant taxonomists. Higher categories are admitted to be even more subjective.

Few thinking systematists would seriously question the validity of Dr. Mayr's principal generalizations. For the most part, very wisely, he has left their application in groups with which he is not familiar to specialists in those fields. As has been pointed out, there seems to be little occasion at the present time to apply the concept of polytypic species to the nomenclature of plant species, at least not to the same extent to which it has been found useful among the birds. This is particularly true in the genus *Calochortus* with which this reviewer is most familiar. Here, contrary to Dr. Mayr's suggestion, each of the species groups (subsections) is not comparable to a polytypic species, but to many an avian genus! The vast majority of the species of *Calochortus* are polytypic, so much so that the consistent description and naming of geographic subspecies would burden the nomenclature of this genus with hundreds of cumbersome trinomials. Such certainly would confuse, not simplify, the existing situation.

The appearance of Dr. Mayr's lucid and stimulating book marks an important point in the development of a sane and comprehensible biological classification. It is a fitting companion volume to Dobzhansky's "Genetics and the Origin of Species," and like that work should be read and understood by every individual who would be called a systematist.—MARION OWNBEY, State College of Washington.

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VIGETHIA, A NEW GENUS OF COMPOSITAE BASED ON
WYETHIA MEXICANA WATSON

WILLIAM A. WEBER

Current studies in the genus *Wyethia* (Compositae) reveal that the entity hitherto called *Wyethia mexicana* Watson differs from the other species of this genus in a number of important characters which are believed to be of generic value. Indeed, Watson expressed his own doubts as to its affinities when, in the original description, he noted that the plant was "rather abnormal in habit and involucre." The presence of fertile ray flowers and alternate leaves may have been prime considerations in deciding the issue, but entirely too much emphasis seems to have been placed upon a single character (that of the pappus) the taxonomic value of which had not been established. Watson placed the species in *Wyethia* with the remark that "the achene, though small, and pappus are wholly those of [that] genus." The real status of *Wyethia mexicana* has since remained obscure because of its great rarity and because a comprehensive study of *Wyethia* has never been made.

The hiatus between *Wyethia mexicana* and the 14 species comprising the remainder of the genus is much greater than that between any other two species. *Wyethia mexicana* is a sub-shrub 3 to 5 feet tall; all other *Wyethia* species are, at most, perennial herbs. The leaves of *Wyethia mexicana* are regularly crenate-dentate; those of other wyethias are entire or only sparsely and irregularly serrate-dentate. The stems of *Wyethia mexicana* are branched, while the stems of other wyethias are simple to the inflorescence. The roots of *Wyethia mexicana* are shallow, spreading and woody; those of other wyethias are deep, cylindric, vertical and fleshy. The achenes of *Wyethia mexicana* are only 3 mm. long exclusive of the pappus, while the achenes of other wyethias are never less than 6 mm. long and may be as long as 15 mm. Finally, no other *Wyethia* species are known to occur south of northern Lower California and northeastern Arizona.

These differences are so striking that in view of our present knowledge of the genus *Wyethia* it seems best to exclude *Wyethia mexicana* from that natural group. With a few exceptions, the characteristics which mark this species could more logically place it in *Viguiera*. However, it differs from *Viguiera* and its relatives in having pistillate ray flowers and alternate leaves, characters which are also believed to be of generic value. Since *Wyethia mexicana* apparently cannot be included in these or in any other established genus, it appears desirable to propose a new genus based on this entity, to occupy a systematic position between *Viguiera* and *Wyethia*.

Vigethia gen. nov. Plantae suffruticosae ramosae foliis alternis ovatis crenato-dentatis triplinerviis. Capitula mediocris magnitudinis, heterogama, radiata, floribus radii ♀ 1-seriatis discique ♂ fertilibus. Involucrum hemisphaericum, bracteis 2-3-seriatis parum inequalibus, apice laxis squarrosisve discum haud superante. Receptaculum planum vel convexiusculum, paleis complicatis flores disci amplectentibus onustum. Corollae radii ligulatae patentes integrae vel minute 1-2-dentatae discique regulares tubo brevi limbo elongato cylindraceo apice breviter 5-fido. Antherae basi subsagittatae. Styli rami appendicimis longis hirtis terminati. Achaeia parva, disci quadrangulo-prismatica, radii compressiuscula, plus minus triangulata breve coronata. Squamellae patentes persistentes 3-4 glabrae coriaceae basibus coalitae.

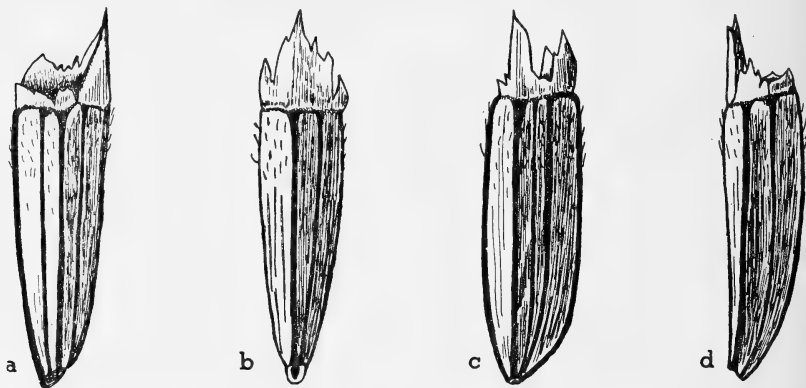


FIG. 1. Achenes of *Vigethia*: a, disk achene, lateral view; b, disk achene, ventral view; c, ray achene, ventral view; d, ray achene, lateral view. ($\times 15$.)

Vigethia mexicana (S. Wats.) comb. nov. Species typica. *Wyethia mexicana* S. Watson in Proc. Am. Acad. 25: 154. 1890.

Sub-shrub, 1 to 1.6 meters high. Root system shallow, the roots coarse, stout, woody. Branches of the year striate, spreading hirsute, older branches glabrate. Leaves alternate, lance-ovate to subcordate, 6 to 10 cm. long, regularly crenate-dentate, green and appressed-hirsute above, cinereous-subtomentose beneath, conspicuously triple-nerved, with petioles one-fourth to one-third the length of the blades. Heads few, 1.5 to 2.5 cm. wide. Involucre hemispherical, about 3-seriate, the phyllaries lanceolate, pubescent and densely ciliate, with squarrose, attenuate tips. Paleae lance-linear with pubescent, dilated apices. Flowers yellow, the ample rays twice as long as the disk, pubescent and minutely resinous-dotted on the tube and back, styliferous and bearing 4 to 5 staminodia, the disk flowers glabrous except for the pubescent lobes. Achenes black, minute, 2.5 to 3 mm. long exclusive of the pappus, sparsely appressed-pubescent



PLATE 20. VIGETHIA MEXICANA (S. Wats.) comb. nov. Photograph of type. (Gray Herbarium, Harvard University.)

on the upper half. Pappus light-colored, one-fourth to one-third the length of the achene.

Range. Known only from the type locality, foothills of the Sierra Madre near Monterrey, Nuevo Leon, Mexico.

Specimens examined. Mexico. Nuevo Leon: Monterrey, San Agustin, 600 meters altitude, July 1, 1911, *Bro. Abbon 145* (United States National Herbarium); grassy foothills of the Sierra Madre near Monterey [*sic*], June 22, 1888, *C. G. Pringle 1923* (Gray Herbarium, type; University of California; United States National Herbarium), June 10, 1889, *2704* (Missouri Botanical Garden; University of California); near Monterrey, 540 meters altitude, May 26, 1908, *C. G. Pringle 15616* (United States National Herbarium); Hacienda Vista Hermosa, 35 miles south of Monterrey, 705 meters altitude, June 29, 1939, *Stephen S. White 1624* (Gray Herbarium); above Horsetail Falls, Villa de Santiago, 750 meters altitude, June 18, 1940, *W. C. Leavenworth 104* (Missouri Botanical Garden; New York Botanical Garden).

Department of Botany,
State College of Washington, Pullman,
August, 1943.

A REVISION OF THE GENUS FREMONTIA

MARGARET HARVEY

The study of the genus *Fremontia* (Sterculiaceae) was suggested to me by Dr. Philip A. Munz of Pomona College to whom I am greatly indebted for guidance and assistance. I wish to express my appreciation to Dr. Charles A. Weatherby of Gray Herbarium for help on the problem of nomenclature and to thank the curators of the following herbaria for kindly lending material which has been used in the preparation of this paper, especially Miss Alice Eastwood who generously lent type specimens from the California Academy of Sciences. The abbreviations indicated are those used in citing specimens: California Academy of Sciences (CAS); Dudley Herbarium, Stanford University (DS); University of California at Los Angeles (LA); New York Botanical Garden (NY); Pomona College (POM); Rancho Santa Ana Botanical Garden (RSA); San Diego Museum of Natural History (SD); University of California (UC).

The genus *Fremontia* was first collected by Colonel J. C. Fremont during his expedition to California from 1845 to 1847 and named and described in 1854 by John Torrey who thus commemorated the explorer for his valuable services to North American botany. An interesting and somewhat complicating situation existed at the time this genus was named in that the generic name *Fremontia* was first applied by Torrey (Fremont, First Rep., p.

95. 1845) to the plant now known as *Sarcobatus vermiculatus*, but the name *Sarcobatus* had already been given to the genus by Nees von Esenbeck, and *Fremontia* was thus a later homonym as applied to *Sarcobatus*. In naming the sterculiaceous genus *Fremontia*, Torrey mentioned the invalidity of the name as first applied and although he himself was responsible for conferring the name *Fremontia* upon two completely different groups, he attempted to clear up the situation and prevent further confusion.

Baillon (Hist. Pl. 4: 70. 1873) has referred the later *Fremontia*, our plant, to a Mexican genus, *Cheiranthodendron* Benth. & Hook. f. (*Chiranthodendron* Cerv.), an older name for *Cheirostemon* Humb. & Bonpl. (*Chirostemum* Cerv.), but Torrey, in publishing the genus as *Fremontia* also knew the genus *Cheirostemon* and pointed out some of the differences. Dr. Gray in one of his later papers (Proc. Amer. Acad. 22: 304. 1887) considered the two genera distinct. Perfect flowers without petals bind together *Fremontia* and *Cheirostemon*, but the zygomorphic flowers and sessile anthers of *Cheirostemon* would seem sufficient to separate it from *Fremontia*.

Coville, in the Death Valley Expedition botanical report (Contrib. U. S. Nat. Herb. 4: 74. 1893), proposed the name *Fremontodendron* to replace *Fremontia*, which he held to be untenable. When the specific name "mexicana" was published in 1917 by Davidson, it was in the combination *Fremontodendron mexicanum*. According to Article 61 of the 1935 International Rules, "a name of a taxonomic group is illegitimate and must be rejected if it is a later homonym . . . even if the earlier homonym is illegitimate . . ." and technically *Fremontodendron* should be adopted. The matter of later generic homonyms was referred by the Congress of 1930 to a committee for investigation and report. The names concerned were taken up alphabetically and report was duly made to the Amsterdam Congress on the letters which had been finished and a list of conserved names published (Kew Bull. Miscel. Inf. p. 81. 1940). The letters F to L were not finished in time for the Congress; technically these are still under consideration by the committee and it might be argued that until its report is made, names like *Fremontia* are likely to be conserved and therefore may be retained, even though technically illegitimate. Since *Fremontia* is the name now used by a majority of western taxonomists, it seems wise to await the results of the investigating committee before making any further changes as to nomenclature.

There has been no previous comprehensive study of the genus as a whole. For more than sixty years following the first description of the genus by Torrey it remained monotypic, until the quite distinct *Fremontodendron mexicanum* was described by Davidson (Bull. So. Calif. Acad. Sci. 16: 50. 1917). No further work was

done until Eastwood described three new species in 1934 (Leaflets West. Bot. 1: 139-140).

Several characters have been used in delimiting species of this genus. The basal pits of the calyx lobes in *F. mexicana* are devoid of hairs; in other species the glands are usually densely hairy. *Fremontia napensis* differs from other species in its smaller flowers, smaller leaves and more slender twigs. *Fremontia crassifolia* may be separated from the *F. californica*-*F. obispoensis* group by the thick, conspicuously three-veined leaves and matted tomentum. Other fairly reliable characters are shape of capsules, size and color of flowers, leaf outline and pubescence.

The species of this genus present an interesting geographical problem: the most restricted and the most distinct species all occur in the coastal mountain ranges of California and Baja California, whereas the polymorphic *F. californica* complex is found growing in the foothills of the hotter and drier inland mountains. One would expect *Fremontia* to occur on one or another of the islands off the coast of southern California but as far as can be ascertained, no report has ever been made of its existence there.

SYSTEMATIC TREATMENT

FREMONTIA Torrey, Smithson. Contrib. 6 (Pl. Fremont.): 5, t. 2. 1854. Not *Fremontia* Torr. in Fremont First Rep., p. 95. 1843. *Fremontodendron* Coville, Contrib. U. S. Nat. Herb. 4: 74. 1893. *Cheiranthodendron* Benth. & Hook. f. of Baillon, Hist. Pl. 4: 127. 1873, in part. *Cheirostemon* Humb. & Bonpl. of Index Kewensis in error (in part).

Evergreen shrubs or small trees with stellate pubescence and mucilaginous inner bark. Leaves simple, alternate. Flowers bisexual, actinomorphic, large and showy. Calyx petaloid, open-campanulate, 5-lobed to below the middle, slightly imbricate, stellate-pubescent externally, villous internally with five pits at the base of the lobes. Petals none. Stamens 5, alternate with the sepals, joined by their filaments for about one-half their length. Ovary superior, 4- or 5-celled, surrounded by the base of the filament tube; style filiform, exserted beyond the stamens. Fruit a densely bristly-hairy capsule, 4- or 5-valved, dehiscent from the apex, persisting for many months; seeds dark, 2 or 3 in each cell.

Type species. *Fremontia californica* Torrey.

KEY TO SPECIES

Pits at base of calyx lobes usually densely hairy.

Flowers small, not over 3.5 cm. in diameter, yellow, often rose-tinged; flowering twigs slender, 2-3 mm. thick; leaves small, less than 2 cm. long, with pubescence on the lower surfaces not matted; capsules conical. Napa and Lake counties

1. *F. napensis*

Flowers more than 4 cm. in diameter, clear yellow.

Leaves thick, heavy, 2.5-4 cm. long, the upper surfaces conspicuously 3-veined, almost smooth above; thick matted tomentum present on stems, petioles, lower leaf surfaces; flowers large, almost 6 cm. in diameter. Coast Ranges, central California

2. *F. crassifolia*

Leaves thin, upper surfaces inconspicuously veined; thick tomentum not present; flowers usually 3.5-5 cm. in diameter.

Flowering twigs slender, 2-3 mm. thick; capsule ovoid, acuminate, the length at least twice the diameter; leaves prevailingy entire. San Luis Obispo County

3. *F. obispoensis*

Flowering twigs thicker, 3-5 mm. thick, capsule ovoid, little longer than thick. Mountain slopes of California

4. *F. californica*

Pits at base of calyx lobes glabrous; leaves thick, heavy, conspicuously 5-veined; flowers large, 6-7 cm. in diameter, orange. San Diego County south into Baja California

5. *F. mexicana*

1. *FREMONTIA NAPENSIS* Eastwood, Leaflets West. Bot. 1: 140. 1934. *F. californica* Torr. var. *napensis* (Eastw.) McMinn, Ill. Man. Calif. Shrubs, 355. 1939.

Shrub, 2-3 meters high, spreading from the base; flowering twigs slender, 1-3 mm. thick, reddish brown, the young growing tips stellate-tomentose; leaves small, thin; blades entire or slightly sinuate to somewhat 3- to 5-lobed, 1-2 (2.5) cm. long, 0.7-1.5 cm. broad, dull or dark green above with few scattered stellate hairs; mature leaves light green below with whitish pubescence, not matted, becoming ferruginous; calyx yellow, sometimes rose-tinged, small, 3-3.5 cm. in diameter; capsule conical, 1.5 cm. long and about 1.5 cm. in diameter at the base.

Locally frequent on chaparral-covered slopes of Napa County and north into Lake County, California. Flowering period, May. Representative material. Lake County: Mirabel Mine, *Eastwood & Howell 5533* (CAS, DS, NY, POM, RSA, UC). Napa County: 15.9 miles southeast Lower Lake, *J. Clausen 1061* (DS, NY, POM, UC); 4 miles north Knoxville Mines, *Mason 10009* (CAS, DS, LA, NY, POM, RSA, UC); Hunting Creek, *Howell 14653* (CAS, DS, LA, NY, POM, RSA, UC); Knoxville, *C. F. Baker 2972* (CAS, NY, POM, UC); north side Mount St. Helena, 1926, *Hobson* (CAS, type).

This species is easily distinguished by the small flowers, the small rather thin leaves and slender branches, and is amply distinct to merit specific rank, being one of the most clear-cut entities of the genus. An interesting specimen which appears to belong to this group has been collected at Pipe Creek, Hemet Valley, Riverside County (*Munz 5805*, POM, UC). As this locality represents the southernmost limit of a number of other northern species, it may well be that this specimen should be referred to *F. napensis*.

2. *FREMONTIA CRASSIFOLIA* Eastwood, Leaflets West. Bot. 1: 139. 1934.

Shrub, 2–3 meters high, twigs thick and heavy, new growth covered with a thick deciduous felt of stellate hairs; leaves thick and heavy, obtuse, 3-lobed; blades 2.5–4.5 cm. long, 2–5 cm. broad, conspicuously 3-veined, dark green above and almost smooth, densely stellate-tomentose below, becoming tawny when old; petioles one-half to one-fourth as long as the blades, densely stellate-pubescent; calyx yellow, large, about 6 cm. in diameter; capsule conical, acuminate, 2.5–3.5 cm. long, 1.5 cm. in diameter at the base.

Coast Ranges from Tehama County to Monterey County, California. Flowering period, March to May. Representative material. Tehama County: Red Bluff, 1917, *Wickes* (CAS). Alameda County: Redwood Peak, 1921, *Kelley* (CAS). San Mateo County: Butano Creek, 1897, *Dudley* (DS). Santa Clara County: on the Soquel Creek, Loma Prieta, *Elmer 5015* (CAS, DS, NY, POM, UC). Santa Cruz County: Big Basin Park, 1918, *Reed* (CAS, type). Monterey County: Salinas, 1917 *Hadden* (CAS).

This is distinguished from other Californian species by the thick, heavy, three-veined leaves, the dense stellate tomentum on the fruits, stems, petioles, and lower surfaces of leaves, by the almost smooth upper surfaces of the leaves and by the large flowers. It may previously have been confused with *F. mexicana* because of the similarity between the two in heavy pubescence, thick leaves and large flowers. However, the hairy basal pits of the calyx lobes, predominantly three- rather than five-veined leaves and clear yellow calyx readily separate *F. crassifolia*.

3. *FREMONTIA OBISPOENSIS* Eastwood, Leaflets West. Bot. 1: 140. 1934.

Shrub, with open branching; flowering twigs somewhat slender, 2–3 mm. thick, young twigs densely stellate-tomentose; leaves small, coriaceous, ovate, obtuse at apex, often with a point, truncate at base; blade prevailingly entire or slightly sinuate, 1.5–2.5 cm. long, 1–2 cm. broad, dull green above, almost smooth, with densely matted white to tawny stellate tomentum below; petiole about one-half the length of the blade; calyx yellow, large, 5–6 cm. in diameter; capsule ovoid acuminate, 2.5–3 cm. long, 1 cm. in diameter at the base.

San Luis Obispo County and south into Santa Barbara County, California. Flowering period, May. Representative material. San Luis Obispo County: Pettitts Canyon, *Eastwood 15159* (CAS, type; NY), 1935, *Sinsheimer* (CAS, DS, NY, RSA); 1 mile south Avenales Ranger Station, *Lee 626* (UC). Santa Barbara County: 4 miles southwest Big Pine Mountain, *Peterson 216* (UC).

This species is a local one, but it seems to be sufficiently distinct to merit specific rank. It resembles varieties *integra* and *diegensis* of *F. californica* in its prevailingly entire leaves but its

consistently slender twigs and long acuminate capsules readily distinguish it.

4. *FREMONTIA CALIFORNICA* Torrey, Smithson. Contrib. 6 (Pl. Fremont.): 5, t. 2. 1854.

Shrub, often large and tree-like, 2-4.5 (7) meters high, spreading to 4 or 5 (9) meters across; bark brownish gray, leaves and flowers produced on short lateral branches; leaves round-ovate to elliptic-ovate, 1-4 (5) cm. long, entire to usually 3-lobed, green and sparsely stellate-pubescent above, white to tawny pubescent or tomentose below; calyx clear yellow, 3.5-6 cm. in diameter, the large glands at the base of the calyx lobes usually densely hairy; capsules ovate-acuminate, 2.5-4 cm. long; seeds brown, dull.

Fremontia californica is exceedingly variable in size and shape of leaf blades with much intergradation of forms. There is also considerable variation in the number of hairs on the basal pits of the calyx lobes. Typically, the glandular pits are quite densely covered with long hairs. However, there is a gradation from densely hairy to almost glabrous with only scattered hairs around the edges of the pits or at the base of the staminal tube. Flowers of this type might be mistaken for those of *F. mexicana* upon a merely superficial examination of this single character. This subglabrous condition so intergrades with the typically hairy condition both morphologically and geographically that it does not seem feasible to make any attempt at varietal segregation based upon this character.

KEY TO VARIETIES OF *FREMONTIA CALIFORNICA*

Leaves variously lobed.

Leaves dull green or dark green above; pubescence decidedly tawny below and often matted 4a. var. *typica*

Leaves bright green above; pubescence whitish below, not tawny. Tehama County 4b. var. *viridis*

Leaves entire, dull green or dark green above; pubescence of lower surfaces becoming tawny.

Petioles short, one-half to one-third the length of the blade. Tulare and Kern counties 4c. var. *integra*

Petioles longer, more than one-half the length of the blade. San Diego County 4d. var. *diegensis*

4a. *FREMONTIA CALIFORNICA* Torrey var. *typica* nom. nov. *F. californica* Torr., Smithson. Contrib. 6 (Pl. Fremont.): 5, t. 2. 1854. *Cheiranthodendron californicum* (Torr.) Baill., Hist. Pl. 4: 70. 1873. *Fremontodendron californicum* (Torr.) Coville, Contrib. U. S. Nat. Herb. 4: 74. 1893. *Cheirostemon californicus* Index Kewensis Supp. 8: 49. 1933, in error.

Leaves variously lobed, dull green or dark green above, pubescence decidedly tawny below and often matted.

Dry foothills of the Sierra Nevada, south to the mountain slopes of southern California. In both the Coast Ranges and the

northern Sierra Nevada foothills the stations for *F. californica* are rare or localized. Apparently the greatest size and development are reached in the foothills of Kern County and of the San Gabriel and San Bernardino mountains where the species is a characteristic and important constituent of the chaparral belt; the typical form becomes rarer southward but does occur in Riverside and San Diego counties.

Representative material. CALIFORNIA. "Sources of the Sacramento," *Fremont's Expedition*, 1846 (NY, type). Shasta County: North Bear Creek, *Johannsen 98* (UC). Tehama County: west Paynes Creek, *Heller 13855* (DS, NY). Nevada County: Grass Valley, 1930, *Coombs* (CAS). Mariposa County: western base Chowchilla Mountains, *Bacigalupi 1468* (DS, POM, UC). Merced County: Merced, *Lemmon 76* (UC). Fresno County: Patterson Mountain, 1914, *Wieslander* (UC). Tulare County: South Fork Kaweah River, *Culbertson 4250* (CAS, NY, POM); Eshom Valley, 1910, *Clemens* (POM, UC). Kern County: 1 mile west Onyx, *Abrams 11940* (DS, POM, UC); Keane, 1903, *Jones* (POM, UC); canyon 5 miles west Tehachapi, *Wolf 1680* (DS, LA, RSA, UC); Fort Tejon, *Vesey 16* (DS, NY), *Abrams & McGregor 272* (DS, NY); San Emigdio Canyon, 1931, *Wolf* (CAS, DS, RSA, UC); Frazier Mountain region, Cuddy Canyon, *Wolf 6933* (CAS, DS, LA, NY, POM, RSA, UC). Santa Barbara County: 2.6 miles northwest Josephine School, *Nordstrom 1330* (UC). Ventura County: Mt. Pinos, 1931, *Epling & Dunn* (LA), 1939, *Dudley* (CAS). Los Angeles County: Acton, *Elmer 3686* (DS, NY, POM); Aliso Canyon—Buckhorn Flats road, *Wolf 7861* (CAS, DS, LA, NY, POM, RSA, UC); Sulphur Springs, *Duran 3510a* (CAS, DS, LA, NY, POM, RSA, UC). San Bernardino County: Horsethief Canyon, *Clokey & Anderson 6749* (NY, RSA, UC); Sawpit Canyon, *Clokey & Anderson 7015* (NY, RSA, UC); Van Dusen Canyon, *Ownbey 1673* (DS, NY, POM); Lytle Creek Canyon, *Abrams 2696* (CAS, DS, NY), *Hall 1222* (DS, NY, UC); south side Cajon Pass, *Howell 2540* (CAS, RSA); Cushenberry Grade, 1926, *Jones* (CAS, POM); foothills, north side San Bernardino Mountains, *Parish 140* (DS, NY, UC); Riverside County: Snow Canyon, 1925, *Jaeger* (NY, POM). San Diego County: Laguna Mountains, *Eastwood 9246* (CAS); Cottonwood, 1893, *Alderson* (UC). ARIZONA. Gila County: Rock Creek, fork Pinto Creek, 1926, *Copple & Cooperider* (U. S. Field Station, Sacaton, Arizona); Mazatzal Mountains, 1935, *Collom* (NY, UC).

According to Dr. Carl B. Wolf (Rancho Santa Ana Botanic Garden Occasional Papers 1: 67. 1938), a shrub in the Frazier Mountain region is probably the largest specimen known in California. Its measurements were as follows: height 23 feet, spread 30 feet, four main trunks had diameters of 16, 16, 12 and 8 inches respectively and the entire tree was covered with thousands of flowers.

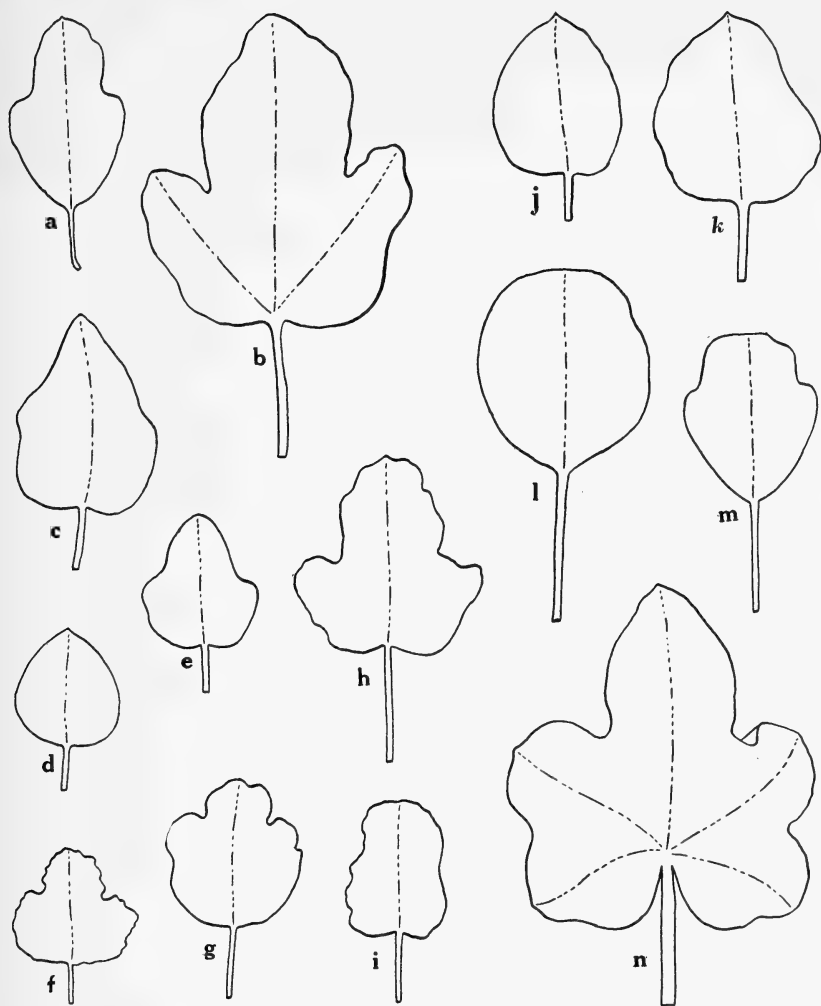


FIG. 1. *Fremontia*. Leaf measurements include both blade and petiole. a, *F. napensis*, Hobson in 1926, type (CAS), length 3.4 cm. b, *F. crassifolia*, Reed in 1918, type (CAS), length 5.8 cm. c-e, *F. obispoensis*, Eastwood 15159, type (CAS), lengths 3.4 cm., 2.4 cm., 2.2 cm. f, *F. californica* var. *typica*, Fremont's Expedition, 1846, type (NY), length 2.1 cm. g, *F. californica* var. *typica*, Wolf 6993, (POM), length 2.9 cm. h-i, *F. californica* var. *viridis*, Eastwood & Howell in 1934, type (CAS), lengths 4.0 cm., 2.7 cm. j-k, *F. californica* var. *integra*, Holman in 1933, type (POM), lengths 2.8 cm., 3.6 cm. l-m, *F. californica* var. *diegensis*, Munz 9716, type (POM), lengths 4.6 cm., 3.7 cm. n, *F. mexicana*, from garden plant, seeds from Ensenada (POM), length 5.5 cm.

The occurrence of *Fremontia* in Arizona is somewhat unexpected; I have neither seen nor heard of other reports of its existence there. The specimens cited are all from the vicinity of

Roosevelt Dam. There seems to be no characteristic by which these specimens can be separated from *F. californica* var. *typica*. The leaves on one specimen are definitely lobed but no other character exists that might link it to either *F. crassifolia* or *F. mexicana*.

4b. *FREMONTIA CALIFORNICA* Torrey var. *viridis* var. nov.

Folia matura viridia, varie 3-lobata; subtus sparse pubescentia, albescentia, non fulva.

Mature leaves bright clear green above, variously 3-lobed; pubescence below rather sparse, not matted, whitish, not at all tawny.

Type. Between Paynes Creek and Red Bluff, Tehama County, California, April 21, 1934, *Eastwood* and *Howell* (CAS 216397).

With var. *typica*, northern Sierra Nevada foothills of Tehama County and south into Butte County, California. Flowering period, April to May. Other collections. Tehama County: Red Bluff, 1917, *Wickes* (CAS); ridge west Paynes Creek, *Heller 15350* (NY, POM, UC); 8 miles above Paynes Creek, *Wolf 9069* (RSA); 2.3 miles below Paynes Creek, *Wolf 8704* (RSA); 10 miles west Mineral, 1939, *Cantelow* (NY). Butte County: Durham, 1935, *Brown* (CAS).

The combination of clear green leaves and whitish pubescence gives this variety a much brighter green appearance than var. *typica*.

4c. *FREMONTIA CALIFORNICA* Torrey var. *integra* var. nov.

Folia subintegra; laminis 1.5–3 (4) cm. longis, supra viridibus, subtus fulvescentibus; laminis bis ad ter longioribus quam petiolis.

Mature leaves subentire, blade 1.5–3 (4) cm. long, dull green above, becoming tawny pubescent below; petioles relatively short, one-half to one-third the length of the blade.

Type. Road to Mineral King, about 10 miles from Generals Highway, Tulare County, California, May 22, 1933, *R. M. Holman* (POM 209740, type; isotypes at CAS, DS, LA, NY, RSA, UC).

With var. *typica*, slopes of foothills and mountains of Tulare and Kern counties, California, rarely south. Flowering period, April to June. Other collections. Tulare County: 25 miles from Lemon Cove, 1925, *Stephens* (POM). Kern County: Greenhorn Mountains, *Weston 106* (CAS); Kern River Canyon, *Gander 7566* (SD); 4 to 5 miles south Tehachapi, *Wolf 2188* (CAS, DS, POM, RSA, UC).

This variety differs from varieties *typica* and *viridis* by its subentire leaves and may be separated from var. *diegensis* by the relatively shorter petioles.

4d. *FREMONTIA CALIFORNICA* Torrey var. *diegensis* var. nov.

Folia integra, supra viridia, subtus fulvescentia; laminis 2–2.5 cm. longis; laminis minus bis longioribus quam petiolis.

Mature leaves entire, dull green or dark green above, becoming tawny pubescent below; blades 2–2.5 cm. long; petioles long, more than half the length of the blade.

Type. Bottom of Vallecito Canyon, Laguna Mountains, San Diego County, California, May 17, 1925, *Philip A. Munz 9716* (POM 97297).

With var. *typica*, foothills and mountains of San Diego County, California. Flowering period, May to June. Other collections. San Diego County: 40 miles east San Diego, *Spencer 469* (NY, POM); Viejas Grade, *Wolf 7989* (RSA), 1941, *Harvey* (POM), 1935, *Gander* (DS, SD); Shaw Canyon, Laguna Mountain, *Gander 2469* (DS, SD).

Subentire leaves separate this variety from varieties *typica* and *viridis* and relatively long petioles distinguish it from the similar but geographically separate var. *integra*.

5. *FREMONTIA MEXICANA* (Davidson) Macbride, Contrib. Gray Herb. n.s. 53: 14. 1918. *Fremontodendron mexicanum* Davidson, Bull. So. Calif. Acad. Sci. 16: 50. 1917. *Fremontia californica* Torr. var. *mexicana* (Davidson) Jepson, Man. Fl. Pl. Calif. 637. 1925.

Large, often tree-like shrub, 2–6 meters high, spreading; branches clothed with densely matted, almost black stellate tomentum; leaves thick, heavy, 5-lobed; blade 2.5–3.5 cm. long and as broad, cordate at the base, conspicuously 5-veined, dark green above with scattered dark stellate hairs, densely matted tomentum below becoming almost black on older leaves; petioles stout, densely tomentose; calyx large, 6–7 cm. in diameter, orange becoming reddish at the base and along the midvein, with rounded pits at base of calyx lobes devoid of hairs; capsule ovoid, acuminate, 3–4 cm. long, 2 cm. in diameter at the base; seeds black, shiny.

Type locality. Dr. Davidson in his original description states that the species was first known from specimens grown by Miss Kate Sessions of San Diego from seed "collected near Ensenada." In a letter to Mr. Frank F. Gander of the San Diego Natural History Museum, Miss Sessions says that she obtained the seed from a plant found at the corner of Fourth and Fir Streets, San Diego, which she always supposed to have been brought in by Charles R. Orcutt. In conversation with Mr. Gander, she also said that she had never collected *Fremontia* seed near Ensenada nor elsewhere in Baja California. Dr. Davidson also states that the specimens upon which the description was based were gathered by Miss Sessions "15 miles from San Diego" while Miss Sessions in conversation with Mr. Gander said she thought that the material which she sent to him all came from her own yard. The species does occur in the wild within twenty miles of San Diego on the west side of Otay Mountain.

Southern San Diego County, south into Baja California. Flowering period, March to July. Representative material. CALIFORNIA. San Diego County: Jamul, 1878, *Sanford* (SD); Monument, 1875, *Dunn* (SD); Otay Mountain, *Wolf* 7982 (RSA), *Gander* 1550 (POM, RSA, SD). "From a garden grown plant, seeds originally from Lower California (Ensenada)," (POM, isotype). BAJA CALIFORNIA: Johnson's Ranch (San Antonio), 1925, *Jones* (CAS, DS, NY, POM); San Antonio Canyon, 1925, *Ballou* (POM, UC); Cypress Canyon, San Antonio Mesa, 1936, *Epling & Stewart* (LA, DS, NY).

Fremontia mexicana is readily separated from other members of the genus: the rounded basal pits of the calyx lobes are devoid of hairs, the calyx is large and orange, the leaves are thick and heavy and conspicuously five-veined. Collections of *F. mexicana* have been reported from as far north as Sonoma County, but all such collections north of San Diego County that I have seen proved to be either *F. californica* var. *typica* or *F. crassifolia*. The manner of flowering of *F. mexicana* is quite different from that of the other species. Instead of a simultaneous mass of flowers, it produces fewer at one time but extends the blooms over a longer flowering period. According to Davidson (Bull. So. Calif. Acad. Sci. 16: 50. 1917), several other characters help to distinguish *F. mexicana* from the other species of *Fremontia*. The seeds are smaller and darker (this difference first caused Mr. Payne to show Dr. Davidson the seed which Miss Sessions had sent to him) and the manner of growth is at first characteristically different. "The seedlings shoot up straight as a miniature tree, while those of *F. californica* branch from near the base at an early stage."

Pomona College,
Claremont, California,
August, 1942.

THE GENUS STYRAX IN CENTRAL AND WESTERN TEXAS

V. L. CORY

Only one species of *Styrax* has been reported as occurring in central Texas whereas none was known from western Texas. The known species is *Styrax platanifolia* Engelm. which ranges from Kimble County east to Llano, Blanco and Travis counties. In this general area in 1940 I found two other well marked members of this genus which are to be differentiated, one as a variety of *S. platanifolia* and the other as a well marked species, types of which are at the Herbarium of the Arnold Arboretum. In making this study I was privileged also to examine material of another undescribed member of the genus that was taken in the Davis Mountains of southwestern Texas in 1914, and apparently

to date is the only collection ever taken of this plant. A contrast of certain characters of the three species concerned is exhibited herewith.

<i>S. platanifolia</i>	<i>S. texana</i>	<i>S. Youngae</i>
Upper leaf surface dull green, glabrous to bearing scattered stellate trichomes, reticulate-veiny.	Upper leaf surface bright green, glabrous, not reticulate-veiny.	Upper leaf surface dull green, densely and coarsely stellate-pubescent, not reticulate-veiny.
Lower and upper leaf surfaces similar.	Lower leaf surface markedly dissimilar to upper leaf surface, bright silvery with a very fine and dense indumentum only.	Lower leaf surface dissimilar to upper leaf surface, but not markedly so; grayish tomentose with a fine and dense indumentum beset with coarse stellate hairs.
Pedicle glabrous to nearly so.	Pedicle puberulent.	Pedicle densely, coarsely stellate-pubescent.
Calyx dark-brown, glabrous to finely puberulent; apex glandular and prominently toothed.	Calyx pale, densely puberulent; apex glandular and prominently toothed.	Calyx dark-brown, densely stellate-pubescent; apex non-glandular, the teeth inconspicuous.
Style pubescent half-way to apex.	Style pubescent only at base.	Style pubescent nearly to apex.

In the description of *S. platanifolia* it is stated that the foliage is glabrous or nearly so and that even the pedicels and calyx are glabrous or nearly so. This characterization is accurate for the plant as it occurs in the northern and eastern portions of its range, but elsewhere the plant is entirely that form described herewith as variety *stellata*.

STYRAX PLATANIFOLIA Engelm. var. *stellata* var. nov. A specie differt foliis indutis trichomatibus stellatis grossis latissimae dispersis, calyce indumento denso minuto obtecto.

Styrax platanifolia var. *stellata* differs from the species in that the leaves bear scattered coarse stellate trichomes and in that the calyx is covered with a dense fine indumentum.

Type. Sabinal Canyon, about six and one-half miles north of Vanderpool, Bandera County, Texas, June 16, 1940, *Cory 34765*.

Representative collections. Kendall County: Spanish Pass, July 5, 1911, *Clemens & Clemens*; *E. J. Palmer 9843, 11474*. Bandera County: Upper Seco Creek, *E. J. Palmer 10237*. Blanco County: Twin Sisters, June 2, 1940, *Mrs. Kush*.

Styrax platanifolia and its variety *stellata* occur in the Edwards Plateau area of Texas, the species centering about southern Llano County and the variety some 50 miles south and southwest in Bandera and Kendall counties. They are not known to occur together or the one to occur in the distributional area of the other.

The upper or western edge of the Coastal Plain lies at an elevation of about 600 feet and the Escarpment of the Edwards Plateau to the west rises to an average elevation of 2200 feet. At its western side (Marathon Basin) the edge of the Edwards Plateau has an elevation of 4000 feet. The various drainage courses make the descent from the Plateau to the Coastal Plains through canyons. The vegetation of these canyons is similar to that of the Escarpment and is unlike that of the Coastal Plains or of the summit of the Plateau. The genus *Styrax* in this area occurs only on the Escarpment and in the canyons. In July, 1940, a new species of *Styrax* was found further west in one of these canyons, and it is described herewith.

Styrax texana sp. nov. Frutex vel arbuscula patens, 1.5–3 m. altus, calciphilus in praeruptis; foliis deciduis, aequae longis ac latis, ad 6.5 mm. latis, integris, apice basique abrupte acutatis, basi caeterum truncata vel rotundata, tenuibus, supra laete viridibus levibus, subtus indumenti causa minute denseque serecei argentatis; floribus post medium Aprilem in anthesi, pedicellatis pedunculatisque, saepius 3–5 glomeratis, pedunculis pedicellis aequantibus vel interdum longioribus, promore recurvatis, subglabratis vel puberulis; calyce pallido, corolla concolori, dense puberulo, campanulato, ca. 5 mm. longo, 4 mm. lato, truncato, margine glandulari 6–7-dentato, dentibus ca. 1 mm. longis, anguste triangularibus, glandulosis; petalis 5, puberulis, anguste ellipticis, obtusis, ad 2 cm. longis; fructu sicco, globoso, ca. 8 mm. diametro, pedicellato, valvis 3, serius dehiscentibus, 1- vel 2-loculato, semine in loculo quove unico; pedicello sub fructu saepissime recurvato, bene subulato; stylo basi crasso, 15–18 mm. longo, basi ad 2 mm. vel ultra canescente, caeterum glabro, gracili, apice curvo vel recurvato.

Spreading, graceful shrub, 1.5–3 m. high, usually growing in inaccessible places on steep limestone cliffs; leaves about as broad as long, up to 6.5 cm. broad, petioled, entire, abruptly acute at apex and base, the base otherwise truncate or rounded, thin, bright green and smooth above, silvery with a very fine and dense silky indumentum below; flowers appearing the last half of April, pedicellate and pedunculate, usually in clusters of 3 to 5, the pedicel puberulent, as much as 1 cm. long, the peduncle about as long as the pedicel or sometimes longer, frequently recurved, subglabrate to puberulent; calyx pale, similar in color to the corolla, densely puberulent, campanulate, about 5 mm. long, 4 mm. broad, truncate, the apex glandular, 6- to 7-toothed, the teeth about 1 mm. long, narrowly triangular and glandular-tipped; petals 5, puberulent, narrowly elliptic, obtuse, up to 2 cm. long; fruit dry, globose, about 8 mm. in diameter, pedicellate, 3-valved, tardily dehiscent, 1- or 2-celled, each cell 1-seeded; pedicel in fruit frequently recurved, tapering throughout; style stout at base, 15–18

mm. long, canescent for 2 mm. or more at the base, glabrous, slender, and curving or recurved above.

The foliage of *S. platanifolia* is of relatively larger leaves of a coarser texture and dull green throughout, undulate or angulate-toothed or even sinuate-lobed, and prominently reticulate-veiny, whereas the foliage of *S. texana* is of rather smaller entire or sub-entire leaves of a finer texture and with the two leaf-surfaces being markedly dissimilar in that the upper surface is smooth and very bright green and the lower surface is bright silvery with a very dense fine and silky covering, and neither surface is reticulate-veiny. Moreover in *S. texana* the calyx is densely puberulent while in *S. platanifolia* the calyx is glabrous or nearly so. The former species occurs to the west of the latter and at an elevation of several hundred feet greater.

Type. Altitude 1975 feet, west side of Polecat Creek, about one-half mile above its junction with Pulliam Creek (which joins the Nueces River at about eleven airline miles southeast), Edwards County, Texas, July 4, 1941, *Cory 34940*.

This type locality is nine and one-half miles south and five miles east of Rocksprings and, on an airline, is about forty-five miles directly west of the Sabinal Canyon locality of *S. platanifolia* var. *stellata*. The only other known locality is in the same county and is about seven miles southwest by airline. Here, on the north side of Cedar Creek Canyon, a tributary of Pulliam Creek, one shrub is growing on a very narrow shelf on a steep limestone cliff.

The discovery plant of *Styrax texana* was found along Pulliam and Polecat creeks on July 4, 1940. The single shrub seen was so unlike the variety of *S. platanifolia* which I had seen in Sabinal Canyon that I became strongly interested in it. In the following year in the same region in Polecat Canyon, additional shrubs of this plant were found higher up on the cliffs. Later, a single shrub of the plant was found along Cedar Creek. In 1942 special efforts were made to see this plant in bloom. On April 5 the sixty-five mile trip to the Cedar Creek site was made; it was found that the foliage of the plant was immature and the inflorescence was only in bud. On April 18 a visit was made to the discovery plant in Polecat Canyon where our efforts were fully rewarded. In our opinion *S. texana* should prove to be a highly desirable ornamental plant for growth in the limestone areas of Texas.

Styrax Youngae sp. nov. Frutex 2.5–3 m. altus; foliis minoribus orbicularibus, majoribus ellipticis, ad 5 cm. longis, 3.5 cm. latis, subintegris, apice basique plus minusve rotundatis vel apice paulo acutatis, tenuibus, supra viridibus at pilis grossis stellatis dense indutis, subtus tomentosus neque argenteis, indumento minuto denso pilis, stellatis grossis consperso, nervis colore stramineo prominentibus, brevipetiolatis; floribus medio Aprili mense in anthesi, 3–7 aggregatis racemosis, pedunculis valido, 4–20 mm.

longo, grosse stellato-pubescente, pedicello valido, 4–8 mm. longo, dense grosseque stellato-pubescente; calyce campanulato, ca. 4 mm. longo latoque, nigro-brunneo, dense stellato-pubescente, apice truncato, eglanduloso, dentibus inconspicuis; petalis 5, 15–17 mm. longis, anguste ellipticis obtusis, dense stellato-puberulis; fructu ignoto; stylo valido, 16–17 mm. longo, fere ad apicem stellato-pubescente.

Plant a shrub, 2.5–3 m. high; smaller leaves orbicular, larger leaves elliptical, up to 5 cm. long and 3.5 cm. broad, subentire, more or less rounded at the apices and bases or somewhat acute at the apices, thin, green above but densely pubescent with coarse stellate hairs, tomentose below, but not silvery, with a very fine and dense indumentum which is beset with coarse stellate hairs, veins prominent and straw-colored, short-petioled; flowers appearing the middle of April, in racemose clusters of 3–7, peduncles stout, 4–20 mm. long, coarsely stellate-pubescent, pedicels stout, 4–8 mm. long, densely and coarsely stellate pubescent; calyx campanulate, about 4 mm. long and 4 mm. broad, dark-brown, densely stellate-pubescent, apex truncate, non-glandular, the teeth inconspicuous; petals 5, 15–17 mm. long, narrowly elliptic, obtuse, densely stellate-puberulent; fruit not seen; style stout, 16–17 mm. long, stellate-pubescent to near the apex.

Type. Canyon, Davis Mountains, Texas, May 12, 1914, Dr. Mary S. Young (Herbarium of the University of Texas).

This is the only collection of *Styrax* from the mountains of southwestern Texas. The exact type locality is unknown, but likely it was some minor canyon for the larger ones are named and were well known even more than thirty years ago. The description is based upon the type specimen and the species is named in honor of its discoverer.

Both *S. platanifolia* and *S. texana* grow on highly calcareous soil, whereas *S. Youngae* grows in soil of igneous origin and in which free limestone is absent. *S. texana* grows at elevations just below 2,000 feet and *S. platanifolia* grows at elevations of a few hundred feet lower, whereas *S. Youngae* grows at elevations in excess of 4,000 feet. In between the elevations of 2,000 and 4,000 feet in Texas there are no plants whatsoever of *Styrax*. It seems probable that *S. Youngae* is a species of northern Mexico, for at that point in far western Texas there are mountains on both sides of the Rio Grande. Inasmuch as the plant has not been found in the twenty-nine years intervening since its original collection this species must be rare and at its northern limit in the Davis Mountains of southwestern Texas. On the other hand neither *S. platanifolia* nor *S. texana* is likely to be found in northern Mexico, for both species are so far unknown from that portion of the Edwards Plateau which extends along the Rio Grande.

It is known that *Styrax* has disappeared from localities where once it was not uncommon, and it seems to be true that at the

present time it grows mostly in places inaccessible to the Angora goat, or in places where this animal is not grazed. The circumstantial evidence is that the foliage of *Styrax* is palatable as browse to these hardy animals that produce our mohair.

It has not been my pleasure or privilege to meet the late Dr. Mary S. Young, but I do wish to accord my recognition of the accomplishments of this pioneer botanist in her explorations of the flora of the mountains of southwestern Texas by naming the *Styrax* of her collection in her honor. I trust that this may offset my part in pointing out that *Talinum Youngae* C. H. Muller, also a plant of the Davis Mountains, is synonymous with *T. pulchellum* Woot. & Standl.

I wish to acknowledge my good fortune in having had valuable assistance given me by Dr. I. M. Johnston in his study of my material, in criticism of my provisional manuscript, and in the loan of the *Styrax* material from the Herbarium of the Arnold Arboretum, by Dr. B. C. Tharp for criticism of the original manuscript and for the loan of the *Styrax* material from the Herbarium of the University of Texas, and by Dr. P. A. Munz for study of my material, for the loan of *Styrax* material from the Herbarium of Pomona College, and for the loan of the volume of "Das Pflanzenreich" which contains the treatment of Styracaceae. I am deeply grateful to these gentlemen. Furthermore, I wish to express grateful appreciation to Dr. Leon Croizat for valuable assistance given me in the preparation of the Latin descriptions in this manuscript.

Texas Agricultural Experiment Station,
Sonora, Texas,
May 9, 1943.

THE STORY OF PARTHENIUM ALPINUM

GEORGE J. GOODMAN

In the spring of 1834, Thomas Nuttall and John K. Townsend left St. Louis with the Wyeth Expedition, bound for Fort Vancouver, Oregon. One of the plants collected on the expedition was *Parthenium alpinum* (Nutt.) T. & G., first described by Nuttall (9) as *Bolophyta alpina*. This curious little plant, which, except for the heads, resembles a caespitose *Actinea*, has not been recollected along Nuttall's route, and the type locality has not been determined definitely. The data given by Nuttall are indefinite and confusing, and subsequent literature is of little help.

A comparison of Nuttall's description with Townsend's journal will reveal the difficulty. Here are Nuttall's words (p. 348): "Hab. In the Rocky Mountain range; latitude about 42° and seven thousand feet above the level of the sea. On shelving rocks, on the summit of a lofty hill, near the place called the

'Three Butes' by the Canadians, towards the sources of the Platte. Flowering in June."

The "sources of the Platte," that portion of the North Platte where Nuttall was, are certainly in Wyoming. Further, during all of June of 1834, the Wyeth Expedition was in what is now Wyoming. "On the 1st of June, we arrived at Laramie's fork of the Platte, and crossed it without much difficulty" wrote Townsend (12) in his narrative (p. 181). On June 30th the Expedition was still at the rendezvous on the Siskadee (Green River) in western Wyoming. On July 4th "we left Ham's fork this morning" (p. 197). Ham's fork is entirely within western Wyoming. Nuttall states, it will be noted, that the plant was flowering in June. Inasmuch as he described the anthers, style, and stigma, it would seem that he must have collected it in flower. A subsequent collection from northern Utah, made by Dr. Edward H. Graham, was collected *in flower*, in late May. The phrase "flowering in June" cannot be taken as proof of the collecting time, however. It is true that Nuttall's three new species of *Townsendia* (pp. 305-306), his two new species of *Actinella* (p. 379), and his new *Sphaeromeria* (p. 402) are all stated to have been collected near the sources of the Platte and "flowering in June." These are now known to be Wyoming plants, and hence were collected in June. On the other hand, he states that his *Stenotus acaulis* (p. 334) was collected "near the borders of Little Godin River, in the Rocky Mountains. Flowering in June." Nuttall was at "Little Godin River" about August 9.

If the plant really was collected in June, and near the "sources of the Platte," it was probably found 50 to 100 miles up or down the river from Casper, Natrona County. Perhaps Nuttall's "Three Butes" was in Wyoming but the name was not perpetuated in the locality. It is a land of buttes, Twin Buttes, Bear Mountain, Dead Man Butte, Square Top Butte, Red Buttes, and Teapot Dome all being in Natrona County, and appearing on a popular road map. It is noteworthy that two other species of Nuttall, *Actinella Torreyana* and *A. lanata*, have collecting data nearly identical to that of the *Parthenium*, namely (p. 379) "on the lofty hills or mountains, called the 'Three Butes' of the upper Platte, on shelving rocks. Flowering in June." Both of these species occur in Wyoming, and neither is reported in the manuals of the region from as far west as Idaho.

There is evidence, however, that the type locality is 325 miles to the westward, in Idaho, far from the headwaters of the Platte and the Atlantic drainage. "Our encampment this evening," wrote Townsend, in his journal under the date of July 11, 1834, "is on one of the head branches of the Blackfoot River, from which we can see the three remarkable conic summits known by the name of the 'Three Butes' or 'Tetons.' Near these flows the Portneuf, or south branch of the Snake or Lewis River." That

the Three Buttes are obvious on the scene is assured me by Dr. Walter E. Loomis, who kindly made some observations of the terrain when motoring through the region.

Few modern maps retain the name of "Three Buttes" for the conspicuous cones on the north side of the Snake River near Fort Hall and Pocatello, but that they were commonly called that a century ago is documented by Fremont (3, p. 161 [174]) where they are referred to in the journal and on the main map, and by Stansbury (11, p. 93) when he visited Fort Hall in 1849.

Townsend's "Tetons" does not refer, of course, to the Grand Tetons, which are over 100 miles away.

The only collections known to me since Nuttall's are three from Utah. In 1910 Jones (7) published his variety *ligulatum* from "... nearly bare clayey and gravelly knolls on ridges at 6000° alt. forming dense mats . . . Theodore [Duchesne] Utah" Dr. Edward H. Graham (5) subsequently collected the plant 70 miles southwest of Jones' locality, at 6300 feet, on May 26, 1935, in flower; and Mr. E. P. Killip tells me that there is a specimen in the U. S. National Herbarium with these data: "dry rocky places, 7000 ft., San Rafael Swell, Emery Co., Utah; June 6, 1932, W. P. Cottam 5259."

The distances from the Utah stations to the Wyoming and the Idaho possibilities are, coincidentally, practically identical—about 250 miles.

There is little phytogeographic evidence favoring the Idaho more than the Wyoming locality. The distribution of many species in Idaho and northwestward, south through western Wyoming and northern Utah is indicated in manuals of the region, in many monographs, and has been pointed out by others (4, 6). But numerous species found in eastern Wyoming are found in northern Utah, too. For example, of nine other plants described by Nuttall at the time which had similar data, such as "toward the sources of the Platte," "On the Black Hills, near the sources of the Platte," etc., five have been collected in the Uinta Basin, Utah, by Graham. All nine are recorded for Wyoming in the manuals and in Esther Larsen's revision of the genus *Townsendia* (8) but *none* of them are listed for Idaho.

Further evidence that Idaho contains the locality in question is this: Townsend refers to the "Canadians," some of McKay's men, several times while in the vicinity of Fort Hall.

The latitude of the two possible type localities is too nearly the same to be helpful when compared with forty-two degrees as estimated by Nuttall. The elevation given by Nuttall (7000 ft.) favors, slightly, the Wyoming locality, but the collection need not have been made very far to the northwest of Three Buttes, Idaho, toward the Lost River Mountains, to be at 7000 feet.

The manuals and floras of the region (1, p. 179, 2, p. 540, 10, p. 924) all give Wyoming as the range.

Did Nuttall collect his plant near the headwaters of the Platte, in June, as he says, or near the Three Buttes, called thus by the Canadians—as he also says? Future collecting may decide it.

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TWO TYPES OF BROAD-LEAF ERODIUM IN CALIFORNIA

KENNETH A. WAGNON AND HAROLD H. BISWELL¹

Shortly following the initiation of the range forage and cattle investigations at the San Joaquin Experimental Range,² O'Neals, California, in 1935, two distinct forms or types of broad-leaf *Erodium* were observed on the station lands. According to Jepson's manual (4) both types would be classified as *Erodium Botrys* (Cav.) Bertol. Growth habits of the two types differ considerably and often have a pronounced effect on the length of time green forage is available for livestock and on the total bulk of feed produced; therefore, it is economically important to be able to differentiate between them. They are easily recognized both in the cotyledon stage and after the appearance of floral parts,

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² Maintained by the Department of Agriculture, United States Forest Service, in cooperation with the University of California, Berkeley, California.

but are difficult or impossible to separate in the intermediate rosette stage. Several plantings studied in the station greenhouse and in the forage plant nursery all bred true to type, and widely distributed field observations in California have not revealed any evidence of intergradation. Chemical analyses at different comparable growth stages by Gordon and Sampson (3) revealed differences in forage values between the two types, and investigation of collections made by the authors, and as yet unpublished, showed essentially the same differences.

Because these plants differ so markedly in growth habit and have such significance in affecting the forage crop, it seemed worthwhile to check their identity by comparison with Old World species of the genus, particularly of the Mediterranean region, where most of them supposedly originated. During these times when much of the world is cut off from us we must rely on such material as is available to us in American herbaria. Specimens of the two entities were sent to several botanists for identification and were returned with determinations based upon the treatment by Knuth in "Das Pflanzenreich" (5), either as *E. Botrys* and one of its varieties or as *E. Botrys* and one of the closely related species. Fortunately, one of the finest collections of Mediterranean plant specimens to be found in North America is located in the private herbarium of Dr. Herman Knoche at San Jose, California. This herbarium is especially rich in the classical sets of the early Mediterranean collectors as well as in the personal collections of Dr. Knoche. A study was made of all of the species of *Erodium* represented and none of the specimens matched one type of the California material under consideration while the other type was definitely established as *E. Botrys*, a species richly represented in the Knoche herbarium. In the synonymy of Knuth's treatment of *E. Botrys* it was noted that Brumhard (1, 2) had published as a *nomen nudum*, and later validated with a description, the name, *E. Botrys* f. *montanum*, based upon a specimen collected by Hansen from Amador County in California. A collection from Chacabuco in Chile was also cited. Comparison of our material with a duplicate of the Hansen specimen indicates that the two are identical and substantiates the observations of Brumhard. It must be taken for granted, in the absence of evidence to the contrary, that because Brumhard, a European monographer of the group, did not cite European material for an entity which he clearly recognized, he apparently did not encounter such material in any of the herbaria where he studied.

Since the precise taxonomic rank of our material is outside the scope of this paper we will use the name given it by Brumhard and here will only direct to the attention of taxonomists our further observations as to differences between these two entities.

A simple key that has proved very useful for mature plants in the field at the San Joaquin Range follows:

- | | |
|--|---|
| Beak (rostrum) 9.5–12.5 cm. long; fovea surrounded by two plicae; sepals with prominent brownish mucro, upper sepal red-margined; flowers large, petals about twice sepal length, stamens about sepal length | <i>Erodium Botrys</i> |
| Beak (rostrum) 5.5–8.5 cm. long; fovea surrounded by one plica; sepals short-mucronate; flowers small, petals about one and one-fourth sepal length, stamens about one-half sepal length | <i>Erodium Botrys</i>
f. <i>montanum</i> |

The two forms can be readily identified in the seedling stage by their relative size and by the shape of their cotyledons. The seedlings of *E. Botrys* f. *montanum* are smaller and the cotyledons have one small incision in the margin, while those of the species are larger and their cotyledons have several more distinct incisions (fig. 1).

The red margins on the upper sepal of *E. Botrys* and the difference in concentric folds about the fovea of the rostra of the two types are perhaps the characters best used for differentiation, and thus far they have proved infallible. Plants of *E. Botrys* f. *montanum* are not so robust as are those of *E. Botrys* (figs. 2, 3). In the rosette stage the stems of *E. Botrys* f. *montanum* are usually not as reddish or coarse as are those of *E. Botrys*, although it is not always possible to separate the plants accurately on this basis. Simple characters need to be found to separate the plants in the rosette stage under all conditions of habitat. Detailed descriptions of the two entities follow.

ERODIUM BOTRYS (Cav.) Bertol. Annual, 8–90 cm. high. Cotyledons oblong, incised. Stems one to many from base, decumbent to ascendent, upper surfaces usually reddish; pubescence coarsely hirsute, hairs whitish-translucent, retrocurved, often glandular. Basal leaves often numerous, petioles usually equal in length or longer than maximum of lamina, hirsute, hairs whitish-translucent, often glandular, lamina ovate, 3–4 lobate, often sublobate, lobes incised-dentate. Cauline foliage opposite; petioles of lower portion of stem often equal or greater than maximum of lamina, upper often sessile, finely hirsute, hairs whitish-translucent, often glandular, lamina ovate, 3–5 partite, mostly quadripartite, lower segments often divided, lobes acute, incised, sinuses moderate to wide. All leaves usually setose-pilose on veins and margins, glandular hairs often present on veins beneath. Stipules ovate, somewhat acute, membranous, pallid or dusky, ciliate, usually 4–5 mm. wide and long. Peduncles varying in length with the lower up to 20 cm. and the upper 2–6 cm. long, usually reddish above, glandular-pubescent. Involucre multibracteate; bracts ovate or lanceolate, acute, membranous, pallid or dusky, minutely ciliate, about 2 mm. wide and 3 mm. long. Pedicels 1–4, upper surfaces dark red, glandular-

pubescent, 15–25 mm. long, after anthesis usually retrocurved. Calyx inflated following anthesis and more or less refracted after fruit matures. Sepals ovate, midrib produced into a prominent brownish mucro, setose, glandular-pubescent, upper sepal red-margined, 13–15 mm. long and 4–5 mm. wide. Flowers large, lavender, remaining open most of day. Petals spreading, about twice calyx length, obovate and with sparsely pubescent angular base. Stamens five, alternating with five sterile, scale-like filaments, filaments of fertile stamens dilated nearly to apex and toothed, about calyx length. Prominent greenish gland with brownish apex at base of each anther-bearing stamen. Pistil densely silvery-villous. Rostrum 9.5–12.5 cm. long with densely appressed short hairs and minute glandular hairs, inner surface



FIG. 1. Young seedling stage: a, *Erodium Botrys*; b, *Erodium Botrys* f. *montanum*.

barbate; valves with short spreading stiff hairs, bearing twin glabrous foveae which are surrounded by two plicae. Seed 4–4.5 mm. long and about 1.5 mm. in diameter.

The following representative specimens, except where otherwise noted, are in the Knoche herbarium, San Jose, California. Canary Islands: Teneriffe, *Knoche* 771. Algeria: Djebel el Ouach, *Choulette* 517; *Reboud*, April, 1879. Portugal: Lisbon, *J. Daveau*, 1879. Balearica: Majorque, *Knoche* 127. Corsica: Bonifacio, *Knoche* in 1908; Bastelia, *Reverchon*, May 23, 1878. Sicily: Ficuzza, *Parlatore*, without date; (Sicula) Alcano, *Todaro* 630. Turkey: Cavalla, *Sinten* and *Bornmüller* 190. California: O'Neals, Madera County, *Wagon* 2, 102 (Herbarium University of California).

ERODIUM BOTRYS (Cav.) Bertol f. *MONTANUM* Brumhard. Annual, 5–55 cm. high. Cotyledons oblong, usually with one small incision. Stems one to many from base, ascendent to erect; hirsute, hairs whitish-translucent, retrocurved, usually glandular. Basal leaves often numerous, petioles usually equal or greater



FIG. 2. *Erodium Botrys f. montanum* in different stages of growth.

than maximum length of lamina, finely hirsute, often glandular-haired, lamina ovate, 3-4 lobate and often sublobate, lobes incised-dentate. Cauline leaves opposite; petioles of lower portion



FIG. 3. *Erodium Botrys* in different stages of growth.

of stem often equal in length to maximum of lamina, upper sometimes sessile, finely hirsute, often sparsely glandular-haired, lamina ovate, 3-5 partite, mostly quadripartite, lower segment often divided, lobes acute, incised, sinuses narrow to moderate. All leaves setose-pilose especially on veins and margins, glandular hairs sometimes present. Stipules ovate, somewhat acute, membranous, pallid or dusky, ciliate, usually 3-4 mm. long and

3–5 mm. wide. Peduncles vary in length with the lower up to 10 cm. and the upper 1–4 cm. long, glandular-pubescent. Involucre multibracteate; bracts ovate or lanceolate, membranous, pallid or dusky, minutely ciliate, about 1 mm. wide and 1.5 mm. long. Pedicels 1–5, usually dark red, glandular-pubescent, 5–15 mm. long, after anthesis usually retrocurved. Calyx inflated following anthesis and more or less refracted after fruit matures. Sepals ovate, short mucronate, setose, glandular-pubescent, 7–9 mm. long and 2–3 mm. wide. Flowers small, lavender, tending to close early in day. Petals often not spreading, about one and one-fourth times as long as the calyx, obovate with finely pubescent angular base. Stamens ten, the five with anthers alternating with five sterile, scale-like filaments, filaments of fertile stamens dilated nearly to apex and toothed, about one-half calyx length. Small greenish gland at base of each anther-bearing stamen. Pistil densely silvery-villous. Rostrum 5.5–8.5 cm. long with densely appressed short hairs and minute glandular hairs, inner surface barbate, outer surface reddish before ripening; valves with short spreading stiff hairs, bearing twin glabrous foveae which are surrounded by one plica. Seed 3–3.5 mm. long and less than 1 mm. in diameter.

Representative specimens. California: New York Falls, Amador County, *Hansen 502* (Dudley Herbarium, Stanford University); O'Neals, Madera County, *Wagnon 1, 101* (Herbarium University of California).

Erodium Botrys f. *montanum* appears to be more common and widespread in California than the species. The latter, however, has been found in almost pure stands on the northeastern edge of North Sacramento, abundant along the state highway from there to Auburn, and scattered along the Bodega road on the outskirts of Sebastopol. Both types are common in the Sierra foothill section and adjacent valley floor of the San Joaquin Valley. During a five-year period at the San Joaquin Experimental Range, the two types combined comprised from 15 to 42 per cent of the plant cover (6, pp. 13–49). On this area they are important components of the cattle diet.

Perhaps the most significant things from a forage standpoint are the big differences in growth habit in the rate of development and time of maturity. This affects the length of the green feed period and, frequently, the amount of forage produced. Plants of *E. Botrys* f. *montanum* normally begin upright growth about two weeks earlier than those of *E. Botrys*, and also mature about two weeks earlier; thus, when they occur together, the season of green forage availability is usually lengthened by about four weeks. This difference in growth and maturity varies from year to year, depending largely on the amount and distribution of rainfall and

in part on temperature. In the winter of 1938-39, for example, the rainfall was light and its distribution unfavorable to the best development of both types; as a result, the vegetative development of both types was retarded and the season of available green feed was shortened. On the other hand, in the winter of 1941-42 cold weather and dry spells so restricted the early-growing f. *montanum* that it matured about April 1; favorable weather after this date resulted in the later-growing *E. Botrys* maturing about mid-May. This lengthened the green forage season by about six weeks. Besides greatly expanding the green feed season the combination greatly increased total forage production.

Just where *Erodium Botrys* f. *montanum* originated is a matter of great scientific interest. Are we to assume that it is an emigrant from some source as yet undisclosed to us? Or, is it a California ecotype selected by the environment out of a diverse genetic population which developed from the original importation of *E. Botrys*? Is the Chilean material cited by Brumhard the same as the California material or is it another ecotype? These questions must of necessity be answered before a proper taxonomic evaluation of *E. Botrys* f. *montanum* can be undertaken.

The authors wish to express appreciation to Dr. H. L. Mason, Department of Botany, University of California, for assistance in the identification of the plants and for revision of the initial manuscript, to Dr. Herman Knoche, author of "Flora Balearica," whose remarkable herbarium of Mediterranean plants was made available for our use, and to Mr. W. A. Dayton, of the United States Forest Service, for the use of the drawings in figures 2 and 3 and for the reading of the original manuscript. Thanks are also given to Dr. W. W. Robbins, of the University of California, for helping with the descriptions and for reading the manuscript.

San Joaquin Experimental Range,
O'Neals, California,
January, 1943.

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REVIEW

Tertiary Prairie Grasses and Other Herbs from the High Plains. By MAXIM K. ELIAS. Geological Society of America, Special Papers, number 41. 176 pages, 6 tables, 7 plates. 1942.

The student of living plants who judges from the title of this monograph that it deals entirely with the fossilized hulls of plants long dead is due for a pleasant surprise. Dr. Elias begins his work with an exhaustive review of modern research in all phases of agrostology, in which he refers not only to the classical authorities on the subject, but in addition to several valuable and little known recent contributions to the ecology and morphology of grasses. He then gives a remarkably thorough description of the morphology and taxonomy of the tribe Stipeae, to which belong nearly all of the fossil grasses described by him. The modern genera and many of their species are carefully treated, and many important new diagnostic characteristics are described. These result from a careful comparative study and a penetrating analysis of one of the most complex and diverse series of structures in the grasses, the fruiting lemma or hull of the Stipeae.

Based on this study, Dr. Elias presents a new division into sections of the genus *Stipa*, one of the largest and most diverse of the entire family Gramineae. The nine sections recognized by him may have to be somewhat modified, and more may have to be added as our knowledge of the details of the morphology of the various species becomes more complete, but there is no doubt that Dr. Elias' system is by far the nearest approach to a natural one that has yet been achieved. It will be a fundamental basis for all future work on *Stipa*. Every botanist interested in the grasses should read carefully the first part of this work.

After having spent 72 of the 146 pages of text on this study of living grasses, Dr. Elias occupies a large part of the remainder with a careful description of the large series of beautifully preserved fossil fruits of Gramineae and Boraginaceae, which he has discovered and collected during the past ten years on the plains of Nebraska, Kansas, and adjacent states. Their age, as determined by a careful analysis of the geological formations in which they occur, is late Tertiary, principally late Miocene to middle Pliocene. Most of them are referred to the fossil genus *Stipidium*, considered closely related and directly ancestral to the modern *Stipa*. There are, however, a number of species of the anomalous fossil genus *Berriochloa*; one of another extinct genus, *Paleoeriocoma*, perhaps ancestral to the modern *Oryzopsis hymenoides*; and one of the modern genus *Nassella*, of which all of the modern species are confined to temperate South America. This last discovery is obviously of great importance to students of the modern plant geography of the Americas. In addition to these representatives of the tribe Stipeae, the author describes the fruits of one

fossil species of *Panicum*, one of *Setaria*, and refers to the new fossil genus, *Clementsella*, a fossil species previously described as *Stipa laminarum*. In the Boraginaceae, five species are included, two of them belonging to extinct genera related to the modern *Anchusa* and *Lithospermum*, and three to the modern genus *Krynitzkia*. The original descriptions of many of these species were published by Dr. Elias in earlier papers.

The collection of fossils of the tribe Stipeae is, so far as this reviewer is aware, much the most complete of any series of herbaceous Angiosperms known from any locality. What is more important, the part preserved, the fruiting lemma, is precisely the one which shows the most valuable diagnostic characteristics for the modern species of the tribe. For these reasons, Dr. Elias' contribution to our knowledge of the evolution of this group is unique.

With such fine evidence at hand, Dr. Elias is naturally tempted to reconstruct the phylogenetic history of the entire tribe. It is in this phylogeny that he is on his weakest ground. It is based on two assumptions. In the first place, nearly all of the fossils are referred to an extinct genus, *Stipidium*, although on the basis of the parts preserved they are indistinguishable in all characteristics except size from fruiting lemmas of modern species of the genus *Stipa*. The fossil genus is separated from the modern one because its awn is believed not to have been indurated as are the awns of modern *Stipa* species. This is because no awns or parts of them have been found in the fossil deposits, although thousands of lemmas are known. However, this is only indirect evidence, and one cannot be certain that awns like those of modern *Stipa* species would become preserved and silicified as are the lemmas. In this connection, it is significant to note that although the stems and leaves of *Stipa* are often rather hard and tough, these have not been preserved either. There is, therefore, only indirect evidence that *Stipidium* and *Stipa* are distinct genera, a conclusion which forms the basis of Dr. Elias' belief, as expressed in the chart at the end of his work, that the modern genus *Stipa* originated as recently as the end of the Pliocene epoch. This hypothesis does not agree with evidence from the distribution of living species of the genus, since *Stipa* is represented by numerous diverse species in all continents except Africa, and there are affinities between species which indicate past intermigrations, not only between Eurasia and North America, but also between North and South America and between South America and Australia. The latter connection, which appears to indicate a former Antarctic distribution for certain species of the genus, is strong circumstantial evidence that *Stipa* was already well developed in the middle or even the early part of the Tertiary period.

The second assumption, that the species found in the fossil record of the high plains demonstrate the principle lines of evolution in the tribe Stipeae, is equally open to question. At present, only a small proportion of the species of this tribe occur in steppe or prairie grass formations, and these do not include the species which are the least specialized morphologically, and might therefore be looked upon as the most primitive modern forms. Furthermore, many of these more primitive species have only weakly indurated lemmas, which would probably not be preserved as fossils. In addition, the author gives convincing evidence of the migration of some of the species into the area, as well as their sudden disappearance, apparently through migration away from the region of the fossil deposits. The reader, therefore, cannot help thinking that much of the evolution of the tribe Stipeae during the Miocene and Pliocene periods took place outside of the Great Plains area, and that some of the more recent fossil species evolved not from earlier species of the same region, but from species living elsewhere. This seems particularly likely in the case of the two Pliocene species *Paleoeriocoma Hitchcocki* and *Nassella amphora*. For this reason, some of the evolutionary trends postulated by Dr. Elias must still be regarded as hypothetical and based on indirect evidence. It is to be hoped that paleobotanists will make discoveries similar to those of Dr. Elias elsewhere in the world, so that a nearer approach to a complete distributional picture of the fossil members of this tribe can be obtained.

There are, unfortunately, a few minor nomenclatorial discrepancies in the monograph. For instance, *Stipidium* sect. *Parastipidium* (p. 87) is recognized as a separate genus in the chart, Plate 17. Similarly, *S. variegatum* modification *Dartoni* (p. 83) is referred to on p. 116 as *S. Dartoni*, while *S. Schereri* mut. *marilandense* (p. 88) appears in the chart as *Parastipidium marilandense*. These errors apparently reflect the natural changes of opinion which the author underwent during his pioneer work on this difficult group, and could perhaps have been avoided by more careful editing.

The student of living plants can only hope that this outstandingly careful, painstaking, and original monograph is the forerunner of still further discoveries by Dr. Elias along the same lines, and that other paleobotanists will follow his lead, and give us a more and more complete fossil record of at least this group of herbaceous angiosperms.—G. L. STEBBINS, JR., Division of Genetics, University of California, Berkeley.

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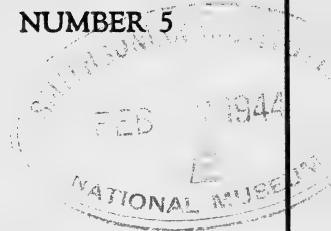
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CYTOLOGICAL EVIDENCE FOR THE TAXONOMIC
POSITION OF SCHIZACHNE PURPURASCENS

W. S. BOYLE

During a cytotaxonomic study of the genus *Melica*, it became necessary to investigate the status of *Schizachne purpurascens* to determine whether or not it should be included in the genus *Melica* or whether it should be treated as a separate genus as suggested by Swallen (4). The natural relationships of the monotypic genus *Schizachne* Hack. have long presented a problem to students of the Gramineae. During the course of its taxonomic history, *S. purpurascens* has been placed in *Avena*, *Trisetum*, *Melica*, and *Bromelica*.

From the morphological standpoint, *Schizachne* shows considerable affinity with *Melica*. The possession of sterile florets at the apex of the spikelet, weak glumes, rounded lemmas, fleshy truncate lodicule, dichotomously branching stigmas, and free caryopses are admittedly indicative of close relationship to *Melica*. *Schizachne* differs from *Melica* in the presence of long bristly hairs on the callus and in its divergent awns.

The karyotype of *Schizachne purpurascens* has now been studied and compared with those of *Melica* species. Specimens of *S. purpurascens* collected near Providence, Rhode Island, were supplied through the kindness of Dr. G. L. Church of Brown University. Seed of *Melica imperfecta* from San Benito County, California, was provided by Dr. G. L. Stebbins, Jr., of the University of California. Root-tips of these were killed and fixed according to Randolph's (1) modification of Navashin's fixative, sectioned at 10 microns, and stained with gentian violet. All of the species of *Melica* thus far investigated possess nine pairs of relatively large chromosomes with considerable difference in their length and in the position of the centromere (fig. 1a). This remarkable uniformity of the chromosome complement among the species of *Melica* was first noted by Stebbins and Love (3). *Schizachne purpurascens*, on the other hand, possesses ten pairs of small chromosomes with little difference in size and all with median to submedian centromeres (fig. 1b). The contrast in number and morphology of the chromosomes in addition to the external morphological differences between *Schizachne* and *Melica* provides ample evidence, in the writer's opinion, for the exclusion of *Schizachne purpurascens* from the genus *Melica*.

Swallen (5) suggested that the genus *Amphibromus* is most closely related to *Schizachne*. On morphological grounds (the cytology of *Amphibromus* is not yet known) this does not seem very plausible as the thin, lanceolate lodicules and the pubescent caryopses of *Amphibromus* would seem sufficient to separate it from the genus *Schizachne*. This viewpoint is furthered by a con-

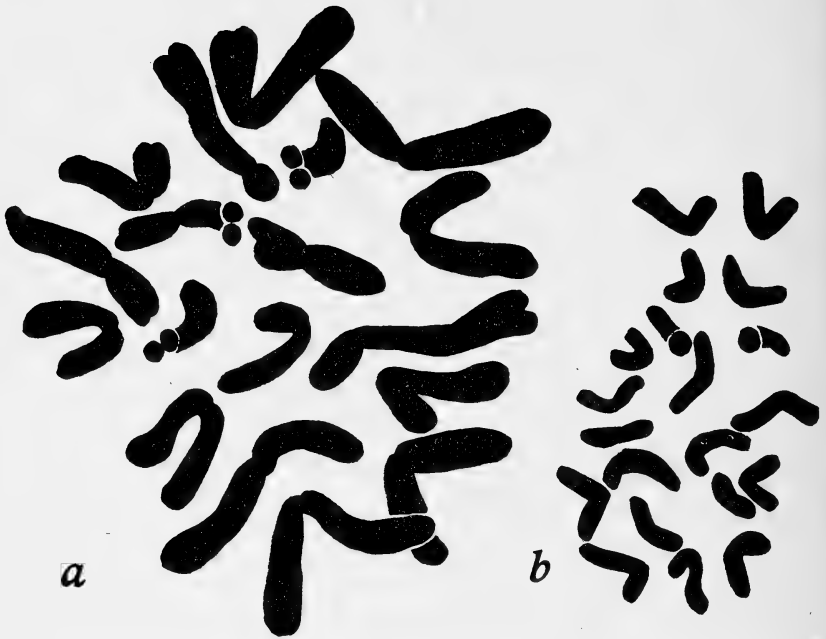


FIG. 1. Karyotypes of *Melica* and *Schizachne*. a, *Melica imperfecta*, $2n=18$; b, *Schizachne purpurascens*, $2n=20$. (Drawings made with camera lucida at a magnification of $5000\times$ and reproduced at $3000\times$.)

sideration of the fact that *Amphibromus* is confined to Australia and South America, while *Schizachne* is found only in the northern hemisphere.

Skorniakov and co-workers (2) have suggested that *Schizachne*, *Melica*, *Glyceria*, *Pleuropogon* and *Anthochloa* be segregated as the tribe *Melicineae*. This viewpoint has much to recommend it; the relationships of *Schizachne* in all probability lie with the above genera.

The author is glad to acknowledge assistance from Dr. G. L. Stebbins, Jr., in this study.

Department of Botany,
University of California, Berkeley,
November, 1943.

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NOTEWORTHY PLANTS OF TEXAS. II. A
NEW SPECIES OF PELTANDRA

FRED A. BARKLEY

In a rather inaccessible portion of the sandy oaklands of Robertson County, eastern Texas, is a bog nearly a kilometer long which varies from a few meters to over a hundred in width. At its upper limit the bog has dried sufficiently so that a grass-sedge meadow separates it from the woodland. The peat of the bog varies from a few inches in depth at the upper end to nearly twelve feet near the lower end. This bog apparently overlays a previous peat deposit, since erosion of the stream a short distance below the bog shows over seven feet of old peat exposed under the sand. The dominant species of the bog is *Sarracenia Sledgei* Macf., which occurs in profusion in it in contrast to other bogs which the author has visited in Texas where this species is either absent or at least not abundant. Many of the plants abundant in other bogs in this area, *Utricularia*, *Iris*, *Xyris*, and *Eriocaulon*, are present here in great profusion; also growing here are *Sparganium*, *Aletris*, *Dulichium*, and *Hypoxis humilis*, none of which is frequent in this area.

In a swamp along the brook above the bog and again in more abundance along the streamlet running through the bog, especially near the lower end, a plant occurs which apparently is an undescribed species of *Peltandra*. A description of this plant follows.

Peltandra *Tharpii*¹ sp. nov.

Herbacea perennis acaulescens; cormis circa 4.5 cm. longis, 6 cm. latis; foliis erectis, numerosis, lanceolatis, sagittatis, acutis vel acuminatis, subintegris vel integris, lobis ad basin angustis, plus minusve acutis, subpeltatis, petiolis $35 \pm$ cm. longis, ad basin vaginatis; scapis $20 \pm$ cm. longis, recurvatis; spathis viridibus, 3.5–4 cm. longis, 1.5–2.5 cm. latis.

¹ Benjamin Carroll Tharp, born November 16, 1885, at Pankey, Grimes County, Texas, son of Angelina M. A. Jenkin and Edwin Harris Tharp, married Norris Wallis of Rockdale, Texas, September 16, 1914. Two sons: Benjamin Carroll, Jr., September 3, 1919, and George Edwin, December 9, 1921. A.B., University of Texas, 1914, A.M., 1915, Ph.D., 1925. Associate professor of biology at Sam Houston Teacher's College 1917–1919; at the University of Texas since 1919, instructor 1919–1920, adjunct professor 1920–1925, associate professor 1925–1933, professor since 1933, director of the herbarium since 1942.

For over twenty years he has directed the work in ecology and taxonomy at the University of Texas where he has been the inspiration and close friend of many students. As an ecologist he has worked on the vegetation of Texas especially in the range lands, served as scientific expert in the Oklahoma-Texas boundary suit, and made other important contributions. Probably his outstanding scientific contribution is in the field of plant taxonomy, where his work on the flora of Texas rightfully places him as dean of Texas plant collectors.

"University of Texas Herbarium Biographical Sketch II"—Fred A. Barkley

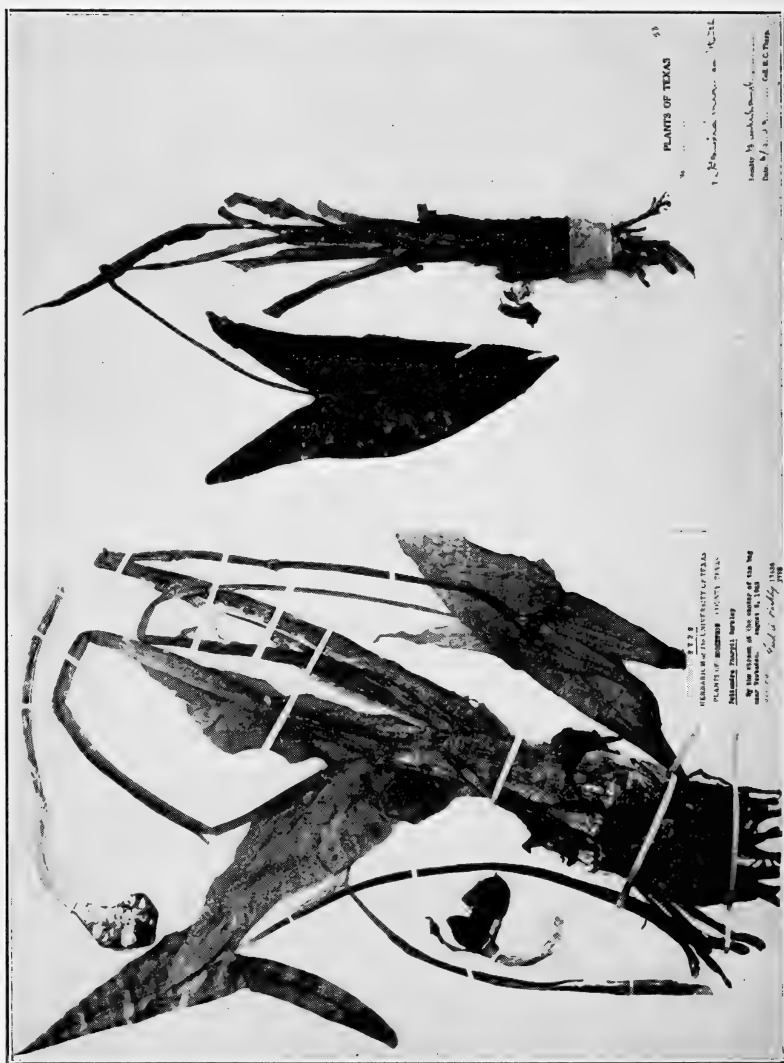


PLATE 21. PELTANDRA IN TEXAS. (Left) *Peltandra Tharpii*; (right) *Peltandra virginica*. Compare size and shape of spathe and leaf.

Acaulescent perennial with numerous, basal, erect, long-petioled, bright dark green leaves from a large corm, petiole sheathing below, slender above, $3.5 \pm$ dm. long, blades about 20 cm. long, lanceolate, sagittate, acute to acuminate, subentire, basal lobes narrow, subacute, slightly united, lateral nerves spreading, marginal nerves prominent; scapes about half as long as the petioles, recurving; spathe green, 3.5–4 cm. long, 1.5–2.5 cm. broad, completely enveloping the spadix which is adnate to it for nearly half its length, upper portion staminate, lower pistillate; fruits slightly angled, $.7 \pm$ cm. broad, $1 \pm$ cm. long.

Vegetatively this plant is very similar to *Peltandra virginica* (L.) Kunth, but differs in the larger narrower leaves, the shorter scape, and in the much shorter and broader spathe.

Specimens examined. TEXAS. Robertson County, in bog near New Baden: June 17, 1943, *Barkley 13043*; by stream at center of bog, August 8, 1943, *Barkley 13424* (type, cotypes widely distributed); marsh along stream one-quarter mile above bog, August 12, 1943, *Painter, Waldorf & Barkley 13425*; in water six inches deep in stream thru bog, October 30, 1943, *Tharp, Brady & Barkley 13698*. All of the above cited specimens are in the University of Texas Herbarium.

The Herbarium,
Department of Botany and Bacteriology,
University of Texas, Austin,
November 26, 1943.

A MONOGRAPH OF THE NORTH AMERICAN SPECIES OF FRITILLARIA

DOROTHY E. BEETLE

The genus *Fritillaria* belongs to the tribe *Tulipeae* of the Liliaceae. Its members, confined to the North Temperate Zone, are found in the Old World throughout Europe, in the northern part of Africa bordering the Mediterranean Sea, Northern Asia and as far south as Persia, Afghanistan, the Himalayas, China and Japan. In North America *Fritillaria* occurs along a narrow coastal strip from the Aleutian Islands to Northern Mexico, extending inland in the Northern United States to the western Dakotas and Nebraska.

Although the number of European and Asiatic specimens seen has not been large, it appears that in the Old World *Fritillaria* is comprised of two sections based on bulb characters and having a racemose inflorescence, and a third section with a single species, *F. Imperialis*, which has a pseudumbellate inflorescence. The majority of the Old World species of *Fritillaria* have a tunicate bulb, the rest having a large perennial squamose bulb without a tunic which is hardly distinguishable from that of *Lilium*. The bulb of the North American species, on the other hand, is a round flat disk without an outside tunic and is covered with moderate-

or small-sized scales. The North American species comprise the section *Liliorhiza* and are geographically centered in California. With the exception of *F. camschatcensis*, which occurs also in Asia, all of the members of the section *Liliorhiza* are American.

The species of *Fritillaria* are quite hardy and occur over a wide range of climate and habitat. About half of them prefer moderate shade in the woods, but are capable of growing in exposed positions near the sea, in the rocky soil and intense sunlight common to chaparral, and on dry slopes under pines. These are slender-stemmed plants, bearing their leaves in whorls and usually having a bulb with a few scales surrounded by rice-grain bulblets. The remaining species prefer the full sun and clay, loam or serpentine soils. In general they are short plants with the leaves confined to the lower half of the stem and with bulbs of fleshy scales of varying sizes. Half their number is restricted to the Great Valley of California and surrounding foothills; none of these occur over a wide area. Hutchison (11, p. 98) has suggested that the *Tulipeae* ecologically is a climax or subclimax group, pointing out that the bulbous character is a climax habit adapted to otherwise destructive climatic conditions.

Fritillaria is of little known economic importance. Its species can, with care, be cultivated as ornamental garden plants. The bulbs, which are crisp, starchy, and without flavor, were eaten by the American Indians. Hooker (8) says of the bulbs of *F. camschatcensis* that "voyagers to Kamschatka bring home small white esculent roots, dried on strings; these are the bitter tubers of this fritillary, which are also copiously eaten by the Indians of Stikine and known by names of Koch or Northwest Rice; but Mr. Tolmie says they are bitter and nauseous." On a specimen from Khutze Inlet, British Columbia, in the University of California Herbarium (McCabe 3483), Mr. McCabe notes that where this species is abundant along the coast, flocks of wild geese dig up the earth in search of the bulbs. Hogs, deer and other wild animals eat the bulbs or plants.

CYTOLOGY AND MORPHOLOGY

Fritillaria is closely allied in morphology and cytology to the other genera in the *Tulipeae*. As in the majority of the tribe, the basic haploid chromosome number is 12, with variations ascribed to polyploidy, fragmentation and fusion of some chromosomes (4, p. 80). The many species, some with a wide distribution and wide adaptation to many ecological conditions, the polyploidy and highly polymorphic nature of several species, indicate a genus near its peak of speciation. Hybridity has been observed only rarely in the field and appears to have been of little or no importance in the development of the evolutionary pattern; no instances are known of the production of hybrid swarms which obscure the identity of the parent species.

In this study, cytological evidence was used where available and an attempt was made to evaluate geographical and ecological factors. The species concept adopted is sufficiently broad to include within the species such autopolyploids as differ only quantitatively from the species and which have not established a distinct range. Following precedent in the genus, the term variety is employed when necessary.

In *Fritillaria lanceolata*, the perplexing variations present necessitated more detailed study. Statistical studies of both living and dried specimens were made to determine whether or not measurements of the plant, of the leaf, flower, pistil, anthers, pollen cells and stomata showed sharply defined size categories that could be used to separate suspected polyploids from diploids. No hiatus appeared, the measurements of each group merging completely into those of the others. Field studies, however, disclosed several cases of polyploidy. An individual plant, having a basic chromosome number of $x = 12 + 4$ fragments and showing irregular division with many bridges, was found in a normal diploid colony near St. Mary's College, Contra Costa County, California. At Alamo, in the same county, a colony under a stand of *Quercus agrifolia* and *Umbellularia californica* along a small stream proved to have diploid plants near the stream and triploid plants, $3x \div 36$, twenty feet higher on the bank. Except that the ground was probably more moist where the diploid plants occurred, the habitat appeared approximately the same for these two groups. In San Mateo County, California, Stebbins collected the only tetraploid plant of *F. lanceolata* known to date. It was four feet tall and occurred in a colony of diploid plants two and one quarter to three feet tall. Such field observations and a careful study of herbarium specimens, in conjunction with cytological studies, make it evident that triploids and tetraploids occasionally occur in a normal diploid colony. None of the polyploids were found to occupy a separate range but have remained as members of the parent colony, thus adding to its diversity.

The perpetuation of much of the diversity of the species is due to asexual propagation by bulb offsets. *Fritillaria lanceolata* occurs nowhere in great abundance, but rather in many isolated stations throughout its range and any viable mutation appearing in a small colony has a fair chance of survival. Many of these local variants which have been asexually perpetuated have been described as new species.

Plants of *F. lanceolata* growing in moist, well-shaded but open situations tend to be very tall with correspondingly large, pale greenish-yellow and inconspicuously marked flowers. In very deep shade the flowers assume an almost vegetative pale green lacking any mottling whatsoever. If the plants are well protected or crowded by other plants in the woods, they are usually reduced in stature with a corresponding decrease in flower size.

On the other hand, where *F. lanceolata* is found growing in the open, in dry soil and in full sunlight, the plants will be short with smaller, predominantly purple and heavily mottled flowers. Examination of both fresh and dried material of *F. exima* Eastwood from Butte County, California, leaves no doubt that it is a very dark-flowered, many-spotted, short form of *F. lanceolata* occupying comparatively exposed localities. Along the seacoast in Marin and Sonoma counties, in places exposed to the wind or salt spray, occurs what has been called *F. lanceolata* var. *tristulis* Grant. These plants are short and stubby, two inches or more tall, with large flowers barely mottled and purple. Toward the interior, the plants increase in stature until they attain a size considered to be typical of the species.

The leaves in *Fritillaria lanceolata* may be long or short, linear or ovate-lanceolate, and this range of variation in the leaves may be found in both tall and short plants with no evident correlation with the habitat.

Tall plants usually have a raceme of from eight to thirteen flowers while short plants may have only one flower. The perianth segments may be ovate to oblong with inner and outer segments quite similar in form. The lanceolate gland is consistently definite in outline but its color varies according to that of the flower and may be inconspicuous in pale flowers.

There is some sterility in the species. Flowers are occasionally found in which the pistil remains undeveloped. Anthers have always been found to be fully developed, but the amount of fertile pollen produced varies, the lowest percentage occurring in the triploids.

It would seem that the *Fritillaria lanceolata* complex is a system of ecotypes in which the various habitats have developed their own races within the species. It would only add to the confusion to recognize each one of the more stable forms as specifically distinct. A basis for the interpretation of this complex is afforded by the realization that *F. lanceolata* is today an actively differentiating species occupying several ecological situations and perpetuating its many variations by asexual reproduction.

Fritillaria pudica is a complex which Gandoger (7) divided into six species on the basis of flower color, size and leaf characters. Turrill (21) reports that plants of this species, grown in the Royal Botanic Gardens, Kew, showed, in various combinations, all the characters employed by Gandoger. Herbarium specimens examined indicate that the species ranges from three to fourteen inches in height, the short plants in general being slender with short linear leaves, although a few are stout with oblanceolate leaves, and those ten inches or more in height usually having a thick stem and oblanceolate leaves, although they may be slender with linear foliage. Larger plants have large flowers and capsules, but the perianth segments are remarkably uniform

TABLE 1. Chromosome numbers in *Fritillaria*. Unless otherwise noted, these counts were made during the course of this study.

Species	Chromosome number	Locality
<i>F. camschatcensis</i>	n = 12, 18	Matsuura (15)
<i>F. folcata</i>	n = 12	Red Mountains, Mount Hamilton Range, Santa Clara County, California
<i>F. lanceolata</i>	n = 12	Moraga Ridge, Contra Costa County, California
<i>F. lanceolata</i>	n = 12, 18	Alamo, Contra Costa County, California
<i>F. lanceolata</i>	n = 12 + 4 fragments	St. Mary's College, Contra Costa County, California
<i>F. lanceolata</i>	n = 24	San Mateo County, California
<i>F. lanceolata</i>	n = 12 + 1 fragment, 18	Near summit Siskiyou Mountains, Jackson County, Oregon
<i>F. lanceolata</i>	n = 12	West of Harts Pass, Whatcom County, Washington
<i>F. liliacea</i>	n = 12	Richmond, Contra Costa County, California
<i>F. phaeanthera</i>	n = 18	Butte County, California
<i>F. pluriflora</i>	n = 12	Near Nord, Butte County, California
<i>F. pudica</i>	n = 12	Pullman, Whitman County, Washington
<i>F. pudica</i>	n = 12	Snake River Canyon, Whitman County, Washington
<i>F. pudica</i>	n = 12 + 1 fragment	Ownbey (personal communication)
<i>F. pudica</i>	n = 12, 13, 39/2	Tischler (20)
<i>F. Purdyi</i>	n = 12	Cobb Valley, Lake County, California
<i>F. recurva</i>	n = 12	North of Lake Tahoe, Placer County, California
<i>F. recurva</i>	n = 12	Near Grants Pass, Josephine County, Oregon
<i>F. recurva</i>	n = 12 + 1 fragment	Tischler (20)
<i>F. recurva</i>		North side of Mount St. Helena, Sonoma County, California
var. <i>coccinea</i>	n = 12	
<i>F. recurva</i>		Cobb Valley, Lake County, California
var. <i>coccinea</i>	n = 12	

in shape, regardless of flower size. Lack of distinctive characters, other than a simple increase in size, suggests the occurrence of polyploidy in this group.

Chromosome counts from two lots of Washington plants show them to be diploid, $n = 12$. A collection of *F. pudica* from the Warner Mountains, Modoc County, California, is reported by Marion Ownbey (personal communication) to be diploid with one fragment. Tischler (19) records counts of $n = 12$, 13, and 39/2 for this species and Darlington (5, p. 248) reports $n = 13$, a number which he believes to be derived by fragmentation.

As in the case of *F. lanceolata*, random measurements of stomata and pollen grains of *F. pudica* showed no hiati separating diploids from suspected polyploids. Similarly, there was no geographic separation; large and small plants occurred together throughout the same area. Except for differences in size, evi-

dence points to a widespread and morphologically rather uniform species in which polyploids have developed and have been perpetuated asexually. These have remained in or near the original colony.

Fritillaria phaeantha Eastwood occurs in Butte and Plumas counties, California, with *F. parviflora* and *F. recurva*. Study of herbarium specimens of *F. phaeantha* showed a complete flower series from pale, greenish, unmottled flowers with recurved perianth segments to red bells resembling small flowers of *F. recurva*. Furthermore, a high degree of sterility was evident; at least one and often all flowers on a plant having undeveloped pistils four millimeters long. The pollen was estimated as only seventy per cent fertile. Triploid chromosome counts, $x = 18$, were obtained from three collections of *F. phaeantha* from Butte County. While it is not yet proven that *F. phaeantha* is a partially sterile hybrid between *F. parviflora* and *F. recurva*, it is evident, in some localities common to both, that they do cross.

TAXONOMY

The genus *Fritillaria* was erected by Linnaeus (14) to accommodate Tournefort's Persian species *Corona Imperialis* and two others, *Fritillaria persica* and *F. regia*. Subsequently, the genus was split into sixteen other genera. Also, some of the species now belonging to it were first described under such well established genera as *Lilium* and *Tulipa*.

In North America, the first species of *Fritillaria* known was *F. camschatcensis*, described by Linnaeus (14) as a *Lilium* native to Kamschatka and Canada. Not until early in the Nineteenth Century when the west was visited by such explorers and collectors as Lewis, Nuttall, Douglas, Frémont and Hartweg were other species discovered. Since this time, as a result of state surveys of California, private explorations and greater settlement of the west, some two dozen names of species and many varieties have been added.

One of the earliest monographs useful in identifying the species of *Fritillaria* was published by Schultes (17) who lists from America *F. lanceolata* and three other species later transferred to *Calochortus*. *Fritillaria pudica* and *F. camschatcensis* as well as two other entities which are now considered synonyms of the latter, were included in *Lilium*.

The genus was treated again by Kunth (13). He accepts seven American species, but merely quotes original descriptions, making no attempt to reduce any of the names to synonymy, nor to ease the task of the botanist seeking to identify species.

Baker's (2) revision of the Tulipeae divides *Fritillaria* into ten subgenera, four of them containing the ten American, as well as some European, species. His divisions were based on bulb and style characters and upon the size and shape of the nectaries. In

spite of having inadequate material and placing too much reliance upon the characters of the nectary, which are variable and extremely difficult to determine in dried material, the revision is well done.

Watson (22)', in his revision of the North American Liliaceae, divides nine species of *Fritillaria* into three sections, the separation being made on the nature of the style, capsule and bulb. Watson's treatment is considerably better than Baker's, but in accepting some of the characters that Baker attributed to some species, he placed obviously unrelated species in the same section.

Bentham and Hooker (3) and Engler and Prantl (6) treat *Fritillaria* identically. They recognize five sections, two of them containing all the American as well as some European species.

Recent floras, particularly those including California, list a dozen or more species of *Fritillaria*. Jepson (12) recognizes thirteen species and six varieties in California. Abrams (1) recognizes fifteen species in the three Pacific states.

The arrangement followed in the present monograph corresponds closely with that proposed by Watson, although the position of some species is shifted and the divisions are not accorded the rank of sections. Seventeen species and two varieties, included in one section, are recognized for North America.

In preparing this monograph, in addition to field observation and collections of the writer, material from the following herbaria was examined: California Academy of Sciences; Clokey Herbarium at the University of California, Berkeley; Dudley Herbarium, Stanford University; Field Museum of Natural History; Willis L. Jepson Herbarium, University of California, Berkeley; Missouri Botanical Garden; New York Botanical Garden; Pomona College; Rocky Mountain Herbarium; University of California, Berkeley; University of California, Davis; State College of Washington; Willamette University. Specimens cited are chiefly those widely distributed among the above herbaria.

The writer takes this opportunity to express gratitude to the many friends and teachers who have generously given assistance: to Dr. Herbert L. Mason under whose direction the investigation was carried on, and to Dr. G. L. Stebbins, Jr., for guidance in the cytological part of the undertaking and assistance in collecting and establishing plants at Berkeley; to Dr. Marion Ownbey and Mr. Milo S. Baker who sent bulbs and cytological material; and to many other friends and collectors who have sent either living material or herbarium specimens; to the curators of the herbaria who made available material for study; to Dr. Alan A. Beetle for suggesting the subject and for assisting the work to completion; to Dr. John L. Morrison for providing the illustration of *F. folcata*.

FRITILLARIA L. Sp. Pl. ed. 1: 303. 1753.

Perennial; bulb of one or more thick, fleshy scales, with or without rice-grain bulblets; basal leaf solitary, ovate or elliptic,

borne in the years before the stem (flowering stalk) appears; stem erect, glabrous, simple; cauline leaves whorled or alternate, lanceolate or linear, sessile; flowers in racemes or solitary and terminal; perianth campanulate or tubiform, deciduous, of six distinct segments in two whorls; segments usually bearing a shallow



FIG. 1. *Fritillaria folcata*. Habit, $\times 1$; flower, $\times 1\frac{1}{2}$.

gland or nectar-bearing area above the base; stamens six, included, inserted on base of the perianth segments, their filaments slender, anthers extrorse, more or less versatile; ovary sessile or

nearly so, style one, entire or trifid; capsule membranaceous, six-angled or winged, three-valved, loculicidally dehiscent; seeds numerous, in two rows in each cell. (Latin *fritillus*, a dice box, named for the shape of the capsule.)

Type species: *Fritillaria Imperialis* L.

Section *Liliorhiza* (Kellogg) Baker, Jour. Linn. Soc. Bot. 14: 211-310. 1874.

Bulbs of several fleshy scales or with rice-grain bulblets, without a tunic and not squamose; flowers racemose or solitary.

KEY TO THE SPECIES

Throughout the key and descriptions, the stem measurement is made from its attachment at the bulb to the top of the inflorescence.

- I. Style entire or shortly three-lobed; perianth not mottled; glands obscure.
 - A. Stem with leaves only on lower half, alternate; bulb of several thick scales.
 1. Flowers yellow; stem 7-35 cm. long ... 1. *F. pudica*
 2. Flowers pink to lavender.
 - a. Perianth segments not recurved; style triparted at apex; stem 20-45 cm. long 2. *F. pluriflora*
 - b. Perianth segments recurved; flowers pink, mauve, or whitish with red stripes; stem 25-38 cm. long 3. *F. striata*
 - B. Stem leafy above, lower third or half naked; leaves whorled; rice-grain bulblets present; flowers pinkish-purple 4. *F. Brandegei*
- II. Style trifid; stigmas linear; glands mostly obvious.
 - A. Stem with leaves on lower half, alternate; bulbs of several scales.
 1. Flowers not mottled.
 - a. Flowers white 5. *F. liliacea*
 - b. Flowers colored.
 - 1) Flowers greenish-yellow.
Stem 30-59 cm. long; odor obnoxious; Great Valley of California 6. *F. agrestis*
 - Stem 12-18 cm. long; flowers purplish, greenish-yellow; confined to serpentine 7. *F. glauca*
 - 2) Flowers brown or greenish-purple; stem 15-45 cm. long 8. *F. biflora*
 2. Flowers mottled.
 - a. Leaves thin; flowers checkered purple and white, shaded with pink; stem 10-35 cm. long 9. *F. Purdyi*
 - b. Leaves succulent; flowers checkered rust and white; stem 12-20 cm. long 10. *F. folcata*
 - B. Stem leafy above, the lower third or half naked; leaves mostly whorled; bulbs usually with rice-grain bulblets.
 1. Perianth not mottled or scarcely so.
 - a. Capsule obtusely angled; flowers

- dark green bronze to purple, extremely small, numerous rice-grain bulblets 11. *F. camschatcensis*
- b. Capsule winged.
- 1) Flowers purplish to greenish-white, occasionally mottled; 12-20 mm. long 12. *F. parviflora*
- 2) Flowers greenish to reddish-yellow; segments recurved; faintly mottled, 10-15 mm. long 13. *F. phaeantha*
2. Perianth mottled.
- a. Flowers tubiform, checkered red and yellow; style cleft one-fifth to one-fourth its length.
- 1) Perianth segments recurved; rice-grain bulblets present 14. *F. recurva*
- 2) Perianth segments usually not recurved; bulb of few scales 14a. *F. recurva*
var. *coccinea*
- b. Flowers campanulate.
- 1) Flowers red, checkered purple; style cleft one-half its length or more; leaves alternate 15. *F. adamantina*
- 2) Flowers not red.
- a) Leaves ovate-lanceolate; flowers mottled brownish-purple on greenish-yellow, 20-40 mm. long 16. *F. lanceolata*
- b) Leaves linear in indefinite whorls; flowers spotted brown, yellow and white, 9-21 mm. long.
- Bulb with rice-grain bulblets; stem slender 17. *F. atropurpurea*
- Bulb of several scales; stem usually stout 17a. *F. atropurpurea*
var. *pinetorum*

1. *FRITILLARIA PUDICA* (Pursh) Spreng. Syst. 2: 64. 1825. *Lilium* ? *pudicum* Pursh, Fl. Am. Sept. 1: 228. 1814. *Amblirion pudicum* Raf. Jour. Physics 89: 102. 1819. *Theresia pudica* Klatt, Hamb. Gart. 16: 439. 1860. *Fritillaria leucella* Gand. Bull. Soc. Bot. France 66: 291. 1920. *F. dichroa* Gand. *ibid.* *F. washingtonensis* Gand. *ibid.* *F. utahensis* Gand. *ibid.* *F. oregonensis* Gand. *ibid.* *F. oreadora* Gand. *ibid.*

Colored illustration. Curtis Bot. Mag. 163: tab. 9617. 1942.

Bulb of small, thick scales; stem 7.5-35 cm. long; leaves alternate, few, scattered, linear to lanceolate, 6.25-20 cm. long, 2-11 mm. wide; flowers 1 to 3, yellow to orange, sometimes brown-veined outside, turning brick red with age; perianth segments

15–19 mm. long, 4–7 mm. wide; gland at base of each segment small; style thick, approximately the length of the perianth segments, stigma knobbed at apex; stamens half the length of perianth segments; capsule obovoid-oblong, 17 mm. long; flowering from March to July, according to elevation. In the few known tetraploids, the above measurements may be doubled.

Distribution. Western United States and British Columbia, also reported from Alberta.

Type. "Plains of Columbia near the Kooskooskee" [Clearwater River, Idaho], 1806, *Lewis*.

Representative material. BRITISH COLUMBIA. Yale County: Lake Okanogan, *Spreadborough* 61279; Grand Forks, Yale and Caribou, *Anderson* 321; Kamloops, *McCabe* 1973. WASHINGTON. Chelan County: Chiwaukum, *St. John* 9447. Kittitas County: Table Mt., *Hitchcock et al.* 3628. Yakima County: Fort Simcoe, *Burgner* 3. Klickitat County: Bingen, *Suksdorf* 5917 (type collection of *F. oredoza*). Okanogan County: near Omak, *Fiker* 41. Grant County: East White Bluffs, *St. John* 3346. Benton County: 10 mi. west of Hanford, *St. John* 8113. Walla Walla County: Wallula, side canyon above Columbia River, *St. John et al.* 3128. Ferry County: 4 mi. above mouth of East Kettle River, *Rogers et al.* 269. Lincoln County: south side of Spokane River at mouth, *Rogers et al.* 258. Stevens County: 7 mi. south of Kettle Falls, *Spiegelberg* 96. Columbia County: Tallow Flat, *Darlington* 27. Pend Oreille County: Newport, *Sprague* 109. Spokane County: Spokane, *Milburge* 236. Whitman County: north of Pullman, *Pickett* 1070. Garfield County: 10 mi. south of Pomeroy, 1921, *Courtney*. Asotin County: Rogersberg, *Ransom & Ridout* 91. OREGON. Jackson County: Table Rock, *Henderson* 5791. Wasco County: Mosier, 1893, *Howell*. Klamath County: McCullom's Mill, Klamath River, *Henderson* 9355. Sherman County: John Day Valley, *Henderson* 5116. Umatilla County: 6 mi. east of Umatilla, *Moore* 120. Grant County: Blue Mts., *Henderson* 5116. County unknown: east Oregon, dry hills, *Cusick* 1831 (type collection of *F. oregonensis*). CALIFORNIA. Siskiyou County: near Yreka, *Butler* 1089. Trinity County: mountains, 1916, *Ruddock*. Shasta County: Fall River Mills, 1923, *Betticel*. Modoc County: Cedar Peak, near Cedar Pass, *Ownbey & Meyer* 2141. Plumas County: Greenville, 1920, *Clemens*. Sierra County: Sierra Valley, 1872–1877, *Lemmon*. MONTANA. Missoula County: Missoula, *Kirkwood* 1052. Lewis and Clark County: Helena, 1893, *Starz*. Cascade County: Belt Creek, 1894, *Anderson*. Gallatin County: Bozeman, 1893, *Gottschatch*. Carbon County: 4 mi. northwest of Red Lodge, 1905, *Draper*. Yellowstone County: Custer, 1890, *Blankinship*. WYOMING. Yellowstone Park, Mammoth Hot Springs, 1889, *Dewart*. Teton County: Burned Ridge, *Williams* 1097. County uncertain: Hayden National Forest, *Nelson* 11356. IDAHO. Kootenai County: Hauser, *Applegate* 6701. Latah County:

Moscow, *Abrams* 538. Nez Perce County: north side of Snake River opposite Clarkston, *Constance & Rollins* 995. Lemhi County: Salmon, Mt. Baldy, *Payson & Payson* 1852. Bannock County: Oxford, 1885, *Leonard*. UTAH. Box Elder County: Wellsville Mts., Cold Water Canyon, *Burke* 2907. Cache County: Providence Bench near mouth of Providence Canyon, *Maguire* 3257. Salt Lake County: Garfield, 1915, *Jones*. Utah County: Mercur, 1896, *Jones*. NEVADA. Washoe County: Verdi, 1895, *Hillman*.

2. FRITILLARIA PLURIFLORA Torrey in Benth. Pl. Hartweg. 338. 1857.

Bulb yellowish, of several scales, 1.25 cm. or more long, stem 20–45 cm. long; leaves clustered on lower part of stem, alternate, elliptical to obovate-oblong, 6.25–12.5 cm. long, 7–15 mm. wide; flowers 1 to 3, rarely 7; perianth segments obovate, 25–35 mm. long, 7–15 mm. wide, pinkish-purple; style triparted at apex; gland continuing as a depressed green vein through center of perianth segment; capsule essentially quadrate, lobes with two dorsal ridges raised so as to suggest wings; flowering from February to April.

Distribution. California and Oregon, in adobe soil of the interior foothills at 175 to 1500 feet elevation.

Type. "California, in valle Sacramento," *Hartweg* 258; [Feather River], *Frémont* 313.

Representative material. CALIFORNIA. Mendocino County: Ukiah, 1898, *Purdy*. Glenn County: Elk Creek, *Duran* 3376. Yolo County: hills west of Winters, 1932, *Smith*. Solano County: Swarney Creek, 1898, *Platt*. Butte County: near Clear Creek, *Brown* 141. OREGON. Lake County: Fremont National Forest, near summit of Crane Creek Mt., *Ferris & Duthie* 247.

3. FRITILLARIA STRIATA Eastwood, Proc. Calif. Acad. Sci. ser. 4, 20: 136. 1931.

Bulb with thick scales; stem 25–37.5 cm. long; leaves on lower half of stem, alternate, slightly glaucous, 6.25–6.87 cm. long, 10–15 mm. wide, ovate-oblong; flowers 2 to 3, occasionally 7, nodding, white, mauve or pink, often with red stripes, fragrant; perianth segments 26–35 mm. long, 7–10 mm. wide, usually recurved; gland obscure, continued as a vein through center of perianth segment; style barely triparted at apex; pistil 15 mm. long, equal to or shorter than the stamens; capsule essentially quadrate, 21 mm. long, unwinged; flowering in March and April.

Distribution. California, in adobe soil of the interior foothills of the San Joaquin Valley at 2500 feet elevation.

Type. Greenhorn Mts., Rattlesnake Grade, 1927, *E. R. Weston* 524.

Representative material. CALIFORNIA. Tulare County: Lindsey, 1928, *Harter*; Strathmore, Fraser Valley, 1927, *Kelly*; Porter-

ville, 1922, *Cantwell*. Kern County: between Kern River and Little Poso Creek, Greenhorn Mts., 1933, *Weston*.

4. FRITILLARIA BRANDEGEI Eastwood, Bull. Torrey Bot. Club 30: 484. 1903. *F. Hutchinsonii* Davidson, Bull. So. Calif. Acad. Sci. 27: 79. 1928.

Bulb with rice-grain bulblets; stem 40–100 cm. long; leaves in several whorls on upper half of stem, usually 5 in a whorl, 5–10 cm. long, 4–20 mm. wide; flowers nodding, 4 to 12, pinkish or purplish; perianth segments 12–17 mm. long, 2–3 mm. wide, spreading and becoming involute with age; gland small, rather triangular; stigma slightly cleft at apex; pistil nearly as long as the perianth segments; stamens shorter than pistil; capsule winged; flowering in April.

Distribution. California, in the yellow pine belt at 5000–7000 feet elevation. The species occurs in the southern Sierra Nevada where there is a gap in the distribution of digger pine (*Pinus Sabiniana*). Granites, rather than the usual ferro-magnesium rocks of the digger pine belt of this altitude underlie the soil. Hence the distribution may be linked with edaphic conditions.

Type. Coburn's Mills, Tulare County, 1890, *T. S. Brandege*.

Representative material. CALIFORNIA. Tulare County: North Bear Creek, *Purpus 1747*. Kern County: Greenhorn Mts., Rattlesnake Road from Bakersfield to Kernville, a short distance below Shirley Meadows, 1927, *Weston*; Greenhorn Mts., below Cedar Creek Public Camp, 1940, *Dearing*.

5. FRITILLARIA LILIACEA Lindl. Bot. Reg. t. 1663. 1835. *Liliorhiza lanceolata* Kellogg, Proc. Calif. Acad. Sci. 2: 46. 1863.

Bulb of round scales; stem 12.5–36.5 cm. long; leaves borne near the base, alternate, ovate to linear, 5–10 cm. long, 4–15 mm. wide; flowers 1 to 3, white with green striations; perianth segments 10–16 mm. long, 5–6 mm. wide, tip of each segment beaked and bearing a tuft of white hairs; gland green, spotted with minute purple dots, continuing as a glandular vein; style cleft half its length; pistil half as long as the perianth segments; stamens shorter than pistil; capsule 15 mm. long, stipitate, the back of each lobe slightly channeled and two-ridged; flowering from February to April.

Distribution. California, from Sonoma County to Monterey County on open hills and fields near the coast.

Type. "California," *Douglas*.

Representative material. CALIFORNIA. Sonoma County: Bennett Peak, 1897, *Baker*. Marin County: ridge east of Garcia, 1929, *Galoway*. Contra Costa County: Richmond, near San Pablo Avenue, *Beetle 14*. Alameda County: Oakland, near Lake Chabot, *Walker 2909*. San Francisco County: San Francisco, *Potrero*

Hills, 1895, *Cannon*. San Mateo County: Redwood City, *Rose 33049*. San Benito County: Aromas, Hickman Ranch, 1915, *Eastwood*. Monterey County: Pfeifer's Point, 1917, *Parsons*.

6. *FRITILLARIA AGRESTIS* Greene, *Erythea* 3: 67. 1895.

Bulb deep-seated, with stout scales; stem 30–50 cm. long; leaves on lower part of stem, alternate, crowded, oblong-oblanceolate to linear-lanceolate, 7.5–11.25 cm. long, 12–17 mm. wide;

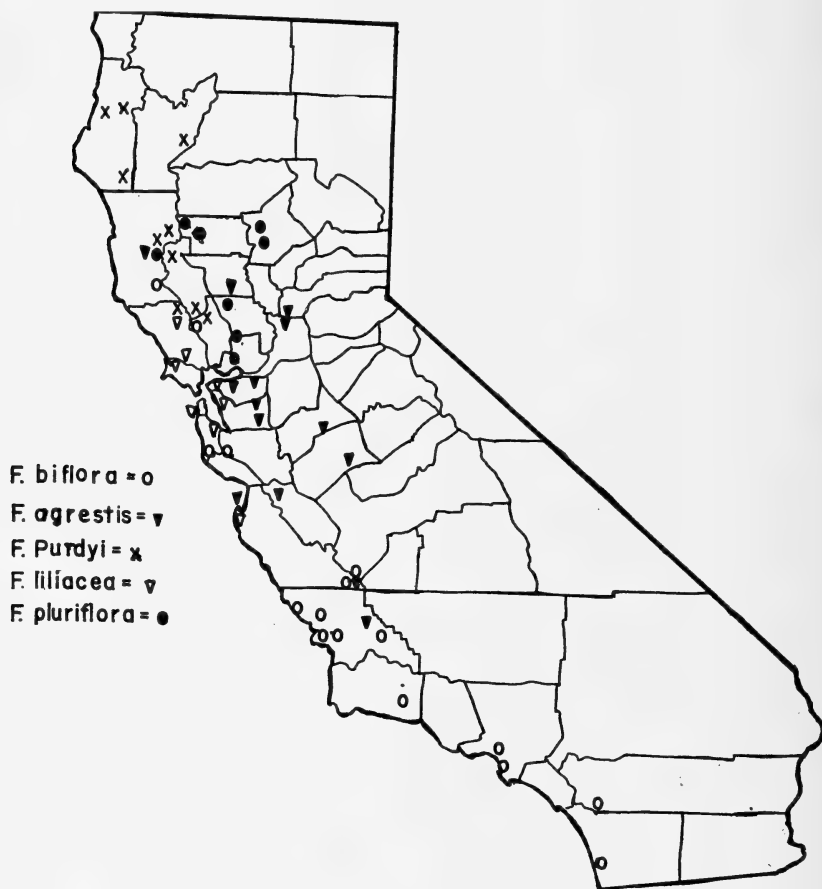


FIG. 2. Distribution of certain species of *Fritillaria* in California.

flowers 1 to 8, on stout recurved pedicels, greenish-yellow with green veins, odor obnoxious; perianth segments beaked, 24–30 mm. long, 7–10 mm. wide; gland green, continuing as a central stripe; style cleft half its length; pistil two-thirds the length of the perianth segments; stamens half as long as perianth seg-

ments; capsule 17 mm. long, essentially quadrate; flowering from March to April.

Distribution. California, at low elevations in the fields and hills of the Great Valley.

Type. California, "Antioch," *Greene*.

Representative material. CALIFORNIA. Mendocino County: Ukiah, 1938, *Purdy*. Colusa County: Arbuckle, *Winter* 751. Placer County: Roseville, 1894, *Congdon*. Sacramento County: 1903, *Durham*. Contra Costa County: Antioch, *Davy* 987. Alameda County: Tesla hills, *Howell* 12590. San Mateo County: New Year Point, Año Nuevo, *Ferris* 2120. Stanislaus County: Turlock, 1921, *Wickes*. Merced County: Planada, near Merced, 1922, *Ebright*. Fresno County: near Trimmer, 1943, *Carter* 42. San Benito County: San Juan, 1921, *Van Denburgh*. Monterey County: near Parkfield, *Eastwood & Howell* 4218. San Luis Obispo County: west side of Cottonwood Pass, *Eastwood & Howell* 2047.

7. FRITILLARIA GLAUCA *Greene*, *Erythea* 1: 153. 1893.

Bulb of few fleshy scales; stem 12.5–17.5 cm. long; leaves 2 to 4, glaucous, alternate, confined to lower half of stem, 3.75–8.75 cm. long, 5–14 mm. wide, ovate; flowers 1 to 2, nodding, purplish or greenish marked with yellow, the colors varying; perianth segments 17–27 mm. long, 6–9 mm. wide, lanceolate; gland not obvious, appearing as a small midvein; style parted half its length; pistil nearly as long as the perianth segment; capsule quadrate, 21 mm. long; flowering from April to July.

Distribution. Northwestern California and southwestern Oregon on hilly serpentine areas, 2000–7000 feet in elevation.

Type. "Oregon, near Waldo," *Howell* 928.

Representative material. OREGON. Douglas County: 1 mi. northwest of Abbots Butte, watershed of South Fork of Umpqua River, 1899, *Leiberg*. Josephine County: top of Tennessee Pass, 4 mi. from Kerby, *Henderson* 5792. CALIFORNIA. Del Norte County: Telephone Point, *Eastwood* 146. Humboldt County: Grouse Mt., *Purdy*. Trinity County: Devils Canyon Mts. at head of Whites Creek, *Tracy* 14565. Glenn County: west of road up Black Butte, *Baker* 10047. Lake County: Hull Mt., *Purdy*.

8. FRITILLARIA BIFLORA *Lindl. Bot. Reg.* 20: t. 1663. 1835. *F. kamtschatsensis* *Torr. Pac. Railroad Rep.* 4: 146. 1857. *F. Grayana* *Reichb. f. and Baker, Jour. Bot.* 16: 263. 1878. *F. biflora* var. *agrestis* *Greene, Manual Botany Bay Region* 311. 1894. *F. succulenta* *Elmer, Bot. Gaz.* 41: 311. 1906. *F. biflora* var. *Ineziana* *Jepson, Fl. Calif.* 1: 306. 1921. *F. biflora* var. *inflata* *Jepson, ibid.* 1921.

Bulb of fleshy scales; stem 15–45 cm. long; leaves scattered or appearing somewhat whorled at the base, oblong to ovate-

lanceolate, 5–10 cm. long, 6–40 mm. wide; flowers nodding, 1 to 7, dark brown or greenish-purple; perianth segments 21–35 mm. long, 5–12 mm. wide; gland appearing as a longitudinal green band extending nearly to apex of perianth segment; style divided one-half to two-thirds its length; pistil and stamens approximately the same length, half the length of the perianth segments; capsule 12–25 mm. long, not winged; flowering from February to June.

Distribution. Southern California in cismontane regions at low altitudes; also localized in Mendocino County, and reported from Mexico (Sesse and Mocino, 1887, "in montibus Sancti Angeli").

Type. "Nova California," 1833, *Douglas*.

Representative material. CALIFORNIA. Mendocino County: Ukiah, *Bolander 4654* (type collection of *F. Grayana*). Napa County: Calistoga, in Napa Range, 1916, *Lutzi*. San Mateo County: Hillsboro, 1914, *Smith* (type of var. *Ineziana*). Santa Clara County: near San Jose, 1877, *Lemmon*. Monterey County: 1886, *Plaskett*. Fresno County: Coalinga to Parkfield, *Peirson 5647*. San Luis Obispo County: San Simeon Bay, 1934, *Snu-shaimer*. Santa Barbara County: road to Mt. Figueroa, *Schreiber 1626*. Los Angeles County: San Dimas, 1897, *Chandler*. Riverside County: Winchester, *Hall 384*. San Diego County: Point Loma, 1895, *Brandege*.

9. *FRITILLARIA PURDYI* Eastwood, Bull. Torrey Bot. Club 29: 75. 1902.

Bulb of fleshy scales; stem 10–35 cm. long; leaves ovate, alternate, crowded at the base, 2.5–6.25 cm. long, 6–16 mm. wide; flowers 1 to 7, checkered purple and white with pink shadings, revolute towards the apex which bears a tuft of whitish hairs; perianth segments 20–22 mm. long, 7–9 mm. wide; gland not obvious, a nectariferous area at base of perianth segment; style cleft half its length; pistil 15 mm. long; anthers lavender-pink, becoming yellow; capsule about as broad as high, not winged; flowering from March to June.

Distribution. California, in the inner Coast Ranges on serpentine ridges at 2500–6900 feet elevation.

Type. Humboldt County, California. "Kneeland, cultivated at Purdy Gardens from material sent by Lowe," 1901, *Purdy*.

Representative material. CALIFORNIA. Humboldt County: Chalk Mt., 1923, *Barnwell*. Trinity County: Lewiston, 1915, *Philips*. Mendocino County: Buck Rock Ridge, *Eastwood 15297*. Lake County: Cobb Valley, near Cobb, *Beetle 26*. Sonoma County: Mt. St. Helena, *Eastwood 4660*. Napa County: Palisades, Mayacama Range, north of Calistoga, *Applegate 7038*.

10. *Fritillaria folcata* (Jepson) comb. nov. *F. atropurpurea* var. *folcata* Jepson, Fl. Calif. 1: 309. 1921.

Bulb of several fleshy scales; stem slender, 12.5–20 cm. long; leaves 2 to 6, alternate, scattered, succulent and somewhat folded, 3.75–8.75 cm. long, 7–15 mm. wide; flowers 1 to 4, erect, campanulate, greenish without, mottled rusty brown and yellow within; perianth segments obovate, 15–22 mm. long, 5–7 mm. wide, tuft of hairs at apex pinkish; gland yellow, spotted brown, extending from the base a third the length of the perianth segment; style tripartite; pistil 14 mm. long, longer than the stamens; anthers rust colored before anthesis, turning yellow; capsule 20 mm. long, nearly as broad, acutely angled with horn-like processes at summit and base of angle; flowering from March to May.

Distribution. California, in the inner South Coast Ranges on serpentine talus at 1000–3000 feet elevation.

Type. "San Benito Co., San Benito Peak," *Jepson 2715*.

Representative material. CALIFORNIA. Stanislaus County: Adobe Creek, Red Mts., Mt. Hamilton Range, *Sharsmith 1671, 3579*. Santa Clara County: Colorado Creek, Red Mts., Mt. Hamilton Range, *Beetle 17, Carter 1047*.

The vegetative habit of this species is similar to that of *F. glauca*; the flower more nearly resembles that of *F. Purdyi*. All three species are restricted to serpentine soil.

11. FRITILLARIA CAMSCHATCENSIS (L.) Ker-Gawl. Curtis Bot. Mag. 30: t. 1216. 1809. *Lilium camschatcense* L. Sp. Pl. 1: 303. 1753. *L. quadrifoliatum* Meyer, Reliq. Haenk. 2: 126. 1825. *L. affine* Schult. Syst. Veg. 7: 400. 1829. in part. *Amblirion camschatcense* Sweet, Hort. Brit. 2: 538. 1830.

Bulb with many extremely small bulblets; stem 17.5–65 cm. long, stocky; leaves usually in 3 whorls, 5 to 11 leaves in a whorl, lanceolate, 5–7.5 cm. long, 7–20 mm. wide; flowers 1 to 8, dark green-bronze to purple-brown, rarely spotted with yellow; perianth segments cressulated towards the apex, usually having lamellae on the inner surfaces and bearing a few pinkish hairs at the apex, 25–27 mm. long, 7–9 mm. wide; gland waxy purple, near base of segment; style cleft one-half to two-thirds its length; pistil 15–18 mm. long; stamens 12–14 mm. long; capsule 18–38 mm. long, 14–24 mm. wide, not winged; flowering in June.

Distribution. Alaska to Washington and west into Kamtchatka and Japan, occurring near the coast. Hultén (10, pp. 38–48) lists this species as one of the group of plants (south Berengia radiants) which after the Pleistocene glaciations re-occupied their original area of the Bering Sea, Japan, Kamtchatka, and the coast of Alaska and Canada, but which also spread farther south than before in both America and Asia.

Type locality. "Canada and Kamtchatka."

Representative material. ALASKA. Unalaska Is., 1920, *Stewart*. Popof Is., Shumagin Islands, *Trelease et al. 3231*. Kodiak Is.,

Alitak Bay, 1924, *Miner*. Dolonu, 1913, *Beach*. Afoguak, 1917, *Noyes*. Excursion Inlet, 1926, *Haley*. Shores of Yes Bay, *Howell* 1663. Wingham Is., 1927, *McMillin*. Branoff Is., Kelp Bay, *Walker & Walker* 799. Prince of Wales Is., Kasaan Bay, *Newcombe* 120. Beardslee Is., Glacier Bay, *Anderson* 1199. Khantaak Is., *Funston* 38. Hinchinbrook Is., 1937, *Norberg*. BRITISH COLUMBIA. Banks Is., Colby Bay, *McCabe* 7325. Islets off Moore Islands, north west of Aristazabal Is., *McCabe* 3430. Khutze Inlet, Graham Reach, *McCabe* 3483. Spider Is., *McCabe* 4338. Calvert Is., *McCabe* 4368. Bella Coola, Whiskey Bay, *McCabe* 1589. Queen Charlotte Sound, Ann Is., *McCabe* 1795. Pender Harbor, Garden Bay, *McCabe* 1622. Vancouver Is., Nanaimo, 1887, *Macoun*. Indianpoint Lake, 25 mi. northeast of Barkerville, *McCabe* 98A. WASHINGTON. Whidby Is., *Gardner* 281. Snohomish County: Silverton, *Bouck* 188.

12. FRITILLARIA PARVIFLORA Torr. Pac. Railroad Rept. 4: 146. 1857. Not *F. parviflora* Mart. Hort. Monacensis. 1838. *F. multiflora* Kellogg, Proc. Calif. Acad. 1: 57. 1855, *nomen provisiorium*. *F. micrantha* Heller, Muhlenbergia 6: 83. 1910.

Bulb of a few scales with numerous rice-grain bulblets; stem 47.5–90 cm. long; leaves on upper half of stem, whorled, 4 to 6 in a whorl, linear to linear-lanceolate, 5–15 cm. long, 3–10 mm. wide; flowers nodding, 4 to 10, purplish or greenish-white, occasionally faintly mottled; perianth segments 12–20 mm. long, 4–5 mm. wide, bearing a tuft of white hairs on the apex; gland oblong-lanceolate, on lower third of segment; style trileft one-third to two-thirds its length; pistil 12–13 mm. long; capsule broadly winged, slightly wider than long; flowering from April to June.

Distribution. California in the pine woods of the Sierra Nevada at 1500–6000 feet elevation.

Type. "Calaveras Co., hillsides near Murphy's," *Bigelow*.

Representative material. CALIFORNIA. Plumas County: Greenville, 1921, *Kelley*. Butte County: Forbestown road out of Oroville, 1938, *Purdy*. Sierra County: near Yuba Pass, *Bacigalupi* 1597. Yuba County: Penn Valley, *Jepson* 14826. Nevada County: near Nevada City, 1913, *Coombs*. Placer County: Auburn, hillside below Bloomer Cut, 1891, *Sonne*. Eldorado County: near Placerville, 1907, *Brandeggee*. Amador County: New York Falls, *Hansen* 51. Calaveras County: Angels Camp, near type locality, *Eastwood* 11620. Tuolumne County: Hetch-Hetchy, *Jepson* 3450. Mariposa County: near Kinsley, 1905, *Hoak*. Fresno County: Sugar Pine, 1929, *McDonald*. Tulare County: Sequoia National Park, 1927, *Bevans*.

The only known copy of Martius' work, listed by B. D. Jackson in his "Guide to the Literature of Botany," is shelved in the Lindley Library and is imperfect. Judging from the title, "Hortus regius monacensis seminifer," it appears evident that the

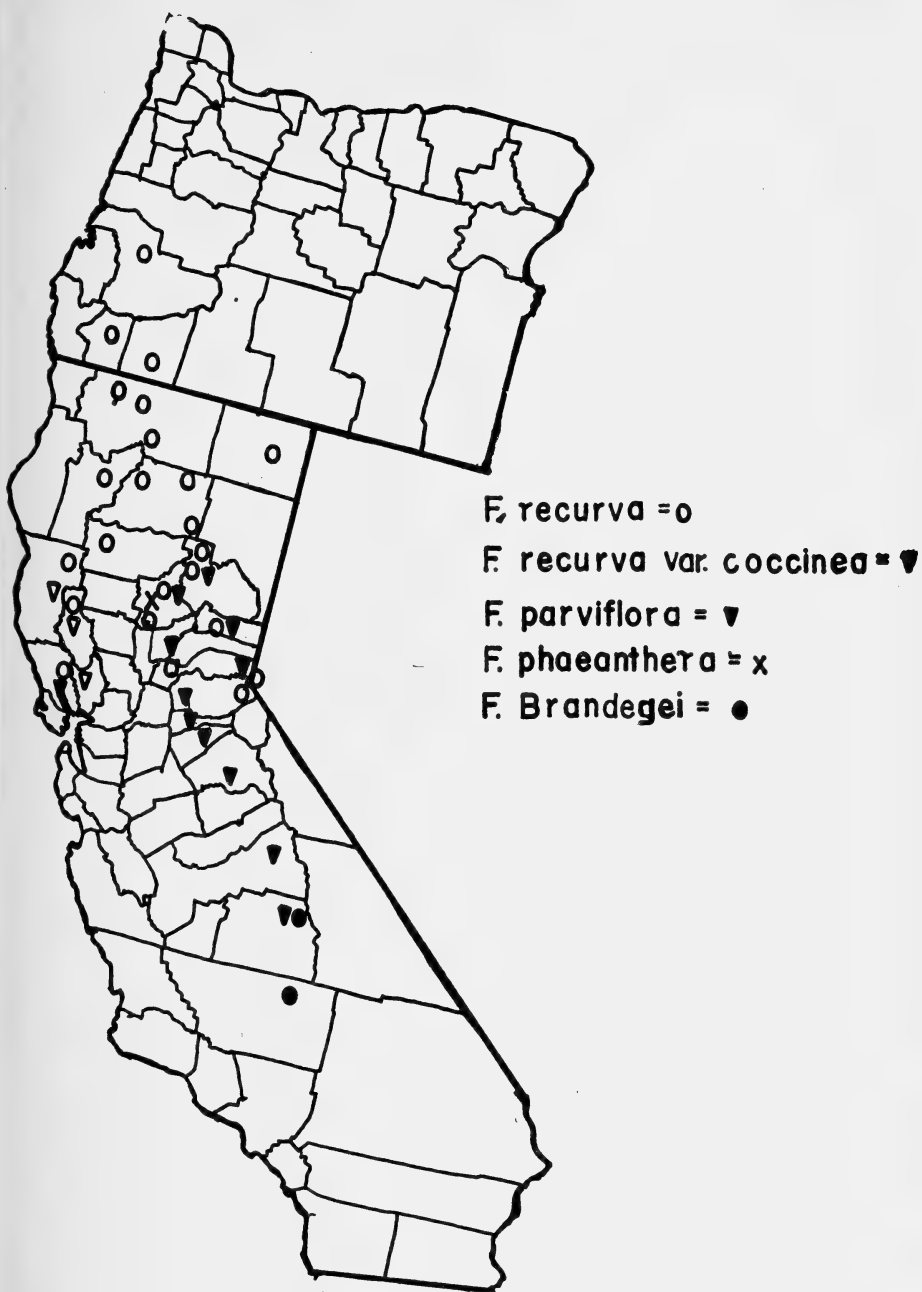


FIG. 3. Distribution of certain species of *Fritillaria* in Oregon and California.

name used by Martius is probably invalidly published, and until such time as this can be definitely established, it seems best to retain *Fritillaria parviflora* Torr. as the name of this entity.

13. *FRITILLARIA PHAEANTHERA* Eastwood, Leaflets West. Bot. 1: 55. 1933.

Bulb of thick scales surrounded by rice-grain bulblets; stem 30–47.5 cm. long; leaves linear to narrowly lanceolate, 3.75–5.6 cm. long, 5–9 mm. wide, whorled, 3 to 5 in a whorl; flowers nodding, open campanulate, 3 to 7, pale greenish-yellow to a speckled reddish-purple; perianth segments sometimes partially recurved, narrowly ovate, 10–15 mm. long, 2 mm. wide, with a tuft of white hairs at apex; gland indistinct, style cleft half its length, often undeveloped; capsule truncate, winged, seen only in the immature condition; flowering from March to June.

Distribution. California, Butte and Napa counties. Hoover (9, p. 76) in a discussion of the upper Sacramento endemism area, which includes Butte County, gives its annual rainfall as twenty-five inches. This may partly account for the restriction to the area of certain species, among them *F. phaeantha*.

Type. "Butte Co., near Durham," 1932, *Mrs. J. H. Morrison*.

Representative material. CALIFORNIA. Butte County: Butte Flower Show, 1929 (4 sheets in Calif. Acad. Sci.); near Durham, 1935, *Brown*; Chico, 1932, *Holt*; near Cherokee, 1942, *Holt*; above Paradise, 1942, *Purdy* (grown at Berkeley). Napa County: Butts Canyon, *Crum* 1740.

14. *FRITILLARIA RECURVA* Benth. Pl. Hartweg. 340. 1857.

Bulb of thick scales with many rice-grain bulblets; stem 30–75 cm. long; leaves in 2 to 3 whorls on upper part of stem, 2 to 5 leaves in a whorl, linear to linear-lanceolate, 3.75–10.6 cm. long, 2–14 mm. wide; flowers nodding, tubiform, 1 to 4, scarlet checkered with yellow, becoming purple in age; perianth segments recurved at their tips, 20–38 mm. long, 5–7 mm. wide; gland prominent, oval, depressed, 6 mm. long, yellow with red spots, occupying the lower third of perianth segment; style cleft one-fourth to one-fifth its length; pistil nearly as long as the flower; stamens somewhat shorter; capsule winged, 9–11 mm. long; flowering from March to July.

Distribution. Interior ranges of southern Oregon, California, and western Nevada.

Type. "California, in montibus Sacramento," [Northern Butte County, Sierra Nevada foothills], *Hartweg* 294.

Representative material. OREGON. Douglas County: rocky hillsides, 1881, *Howell*. Josephine County: Wimmer, 1893, *Hammond*. Jackson County: Siskiyou summit, 1934, *Eastwood & Howell*. CALIFORNIA. Humboldt County: Buck Mt., *Tracy* 4176. Mendocino County: Long Valley, *Bolander* 4708. Sonoma County: Hoods Peak, 1902, *Baker*. Siskiyou County: near Yreka, *Butler*

1191. Trinity County: Carrville, 1916, *Rose*. Shasta County: between Viola and Manton, *Beetle* 70. Tehama County: coast range near Bennett Spring, *Heller* 13001. Lake County: Elk Mt., *Eastwood & Howell* 5704. Modoc County: in timber, 1893, *Baker*. Plumas County: Greenville, 1920, *Clemens*. Butte County: Feather River near Stirling, *Heller* 13161. Sierra County: Cedar Glen, 1920, *Jones*. Placer County: between Tahoe and Truckee, *Beetle* 46. Nevada County: Nevada City, 1913, *Coombs*. NEVADA. Douglas County: Route 50, 1 mi. south of Glen Brook, *Beetle* 77.

14a. *FRITILLARIA RECURVA* var. *COCCINEA* Greene, *Pittonia* 2: 230. 1892. *F. coccinea* Greene, *ibid.*, p. 250.

Bulb of few scales; stem more slender, usually shorter than in the species, 25–75 cm. long; leaves shorter, linear; flowers usually 1 to 3, tips of segments rarely recurved; flowering from March to June.

Distribution. California, in the inner North Coast Ranges in exposed situations. Where the species and its variety overlap in range, they are often difficult to differentiate.

Type. "California, Sonoma Co., Hoods Peak," 1892, *F. T. Bioletti*.

Representative material. CALIFORNIA. Mendocino County: near Ukiah, 1897, *Purdy*. Sonoma County: Mt. St. Helena, *Beetle* 25. Lake County: Cobb Mt., *Beetle* 27. Napa County: Moore's Creek, 2 mi. southeast of Angwin, 1941, *Hemphill*.

15. *FRITILLARIA ADAMANTINA* Peck, *Proc. Biol. Soc. Wash.* 50: 93. 1937.

Bulb with large scales and rice-grain bulblets; stem stout, 45–60 cm. long; leaves numerous, alternate to roughly whorled, borne on the middle section of the stem, 6.88–11.87 cm. long, 4–6 mm. wide; flowers 6 to 12, campanulate, red spotted with purple; pedicels short and thick; perianth segments 20–25 mm. long, 4–7 mm. wide, oblong-lanceolate; gland obscure; style cleft more than half its length; pistil 11–14 mm. long; immature capsule 15 mm. long, obovate, winged; flowering in July.

Distribution. Oregon, west slope of the central Cascade Mountains.

Type. "Oregon, Douglas Co., east bank of Diamond Lake," *Peck* 19490.

Representative material. OREGON. Douglas County: east bank of Diamond Lake, *Peck* 19733.

This species seems most closely related to *F. recurva*, differing from it in the form and disposition of the perianth segments which are erect rather than recurved, the greater degree to which the style is cleft, and the irregular arrangement of the leaves.

16. *FRITILLARIA LANCEOLATA* Pursh, *Fl. Am. Sept.* 1: 230. 1814. *Amblirion lanceolata* Sweet, *Hort. Brit. ed.* 1: 427. 1827. *Lilium*

affine Schult. Syst. Veg. 7: 400. 1829, in part. *Fritillaria mutica* Lindl. Bot. Reg. t. 1663. 1835. *F. lanceolata* var. *floribunda* Benth. Pl. Hartweg. 338. 1857. *F. lanceolata* var. ? Benth. Pl.



FIG. 4. Distribution of certain species of *Fritillaria* in Western North America.

Hartweg. 340. 1857. *F. viridea* Kellogg, Proc. Calif. Acad. Sci. 2: 9. 1863. *Liliorhiza viridea* Kellogg, Proc. Calif. Acad. Sci. 2: 48. 1863. *Fritillaria esculenta* Nutt. ex Baker, Jour. Linn. Soc.

- 14: 271. 1874. *F. lanceolata* var. *gracilis* Wats., Proc. Am. Acad.
 14: 259. 1879. *F. mutica* var. *gracilis* Jepson, Fl. Western Middle
 Calif. 188. 1901. *F. Lunellii* Nelson, Proc. Biol. Soc. Wash. 20:
 35. 1907. *F. lanceolata* var. *tristulis* Grant in Jepson, Fl. Calif. 1:
 308. 1921. *F. ojaiensis* Davidson, Bull. So. Calif. Acad. Sci. 21:
 41. 1922. *F. exima* Eastwood, Leaflets West. Bot. 2: 112. 1938.

Bulb of a few scales and rice-grain bulblets; stem 30–120 cm. long, very stout in taller plants; leaves in several whorls on upper part of stem, usually 3 to 5 in a whorl, ovate-lanceolate, 37.5–162.5 cm. long, 5–30 mm. wide; flowers nodding, 1 to 13, brownish-purple mottled with greenish-yellow, some flowers almost solidly purple, others faintly mottled and pale greenish-yellow; perianth segments 20–40 mm. long, 4–11 mm. wide, ovate to oblong; gland in center of segment, conspicuous, yellowish-green with minute purple dots; style cleft to the middle; capsule 1.6–2.5 cm. long, broadly winged; flowering from February to May.

Distribution. British Columbia to southern California in the fog belt of the coastal hills, mainly in oak and brush associations, but not with redwoods; also east into Idaho.

Type. Washington. "Brand Is., at foot of cascades, Columbia River." 1806, *Lewis*.
 1806, *Lewis*.

Representative material. BRITISH COLUMBIA. New Westminster County: Whytecliffe, Howe Sound, *McCabe* 2556. Yale County: Pinantan, *McCabe* 2411. Vancouver Is., Victoria, 1909, *Anderson*. WASHINGTON. Clallam County: Duvall, *Knoke* 290. San Juan County: San Juan Is., Friday Harbor, *Peck* 12625. Island County: Camano Is., 1895, *Gardner*. Mason County: seashore near county line, *Jones* 6513. Thurston County: Hawks Prairie, *Johnson* 509. Lewis County: Cascade Mts., Goat Mts., *Allen* 235. Cowlitz County: Columbia River bluffs near Kalama, *Thompson* 10128. Whatcom County: Chuckanut Bay, 1890, *Suksdorf*. Skagit County: Fidalgo Is., Snee Oosh, *Mason* 5305. King County: Seattle, 1899, *Smith*. Pierce County: Tacoma, *Flett* 3431. Chelan County: Swauk Creek, Bleweet Pass, *Quick* 1011. Kittitas, Chelan and King counties: Cascade Mts., 1889, *Vasey*. Yakima County: Naches River, 1921, *Thrig*. Klickitat County: Bingen, Falcon Valley [*sic*], *Suksdorf* 312. Okanogan County: Hidden Lakes, Ptarmigan Creek, *Edwards* 264. Spokane County: Liberty Lake, 1919, *Kunholz*. OREGON. Clatsop County: Saddle Mt., 1915, *Gorman*. Lane County: highway near Blue River, *Eastwood & Howell* 1611. Douglas County: South Umpqua River, Roseburg Quadrangle, 1914, *Cusick*. Curry County: Gold Beach, 1916, *Hoyt*. Josephine County: Selma, *Henderson* 5793. Jackson County: near summit Siskiyou Mts., 5 mi. north of California line, *Ownbey & Meyer* 2168. Hood River County: Hood River, *Whited* 1126. Wasco County: foothills of Mt. Hood, *Lunell* (type of *F. Lunellii*). CALIFORNIA. Del Norte County: Crescent City, *East-*

wood 49. Siskiyou County: Hilt, 1917, *Stonehouse*. Humboldt County: Kosbell, Hungry Hollow, 1925, *Kildale*. Trinity County: Weaverville, 1915, *Jenkins*. Tehama County: coast range near Bennett Spring, 1918, *Heller*. Mendocino County: Mendocino City, 1932, *Peterson*. Butte County: Pence Grace, east of Paradise, 1932, *Morrison* (type of *F. exima*). Lake County: Kelseyville, *Irwin* 101. Sonoma County: Mt. St. Helena, Middletown grade, *Jepson* 14823. Napa County: Calistoga, 1915, *Eastwood*. Marin County: Mt. Tamalpais, Cataract Gulch, *Grant* 930. Solano County: Vacaville, 1898, *Platt*. Contra Costa County: Briones Valley, *Chandler* 577. San Francisco County: Bernal Heights, San Francisco, *Mason* 1268. Alameda County: Berkeley, Grizzly Peak, *Davy* 118. San Mateo County: Crystal Springs Lake, *Baker* 5047. Santa Cruz County: Glenwood, 1907, *Davis*. Santa Clara County: Mt. Hamilton Range, Red Mts., Colorado Creek, *Beetle* 16. Stanislaus County: Mt. Hamilton Range, Red Mts., Adobe Creek, *Sharsmith* 3577. Monterey County: Del Monte Heights, 1914, *Woodcock*. San Benito County: New Idria, Cantua Creek, 1893, *Kellogg* (type of *F. viridea*). San Luis Obispo County: Pismo, Pismo Creek, *Munz* 9253. Riverside County: San Bernardino Mts., 1876, *Lemmon*. IDAHO. Kootenai County: north shore Lake Coeur d'Alene, *Hitchcock & Samuel* 2618. Benewah County: Chatcolet, *Warren* 888.

17. FRITILLARIA ATROPURPUREA Nutt. Jour. Acad. Phil. 7: 54. 1834. *F. alba* Nutt. Gen. Am. Pl. 1: 222. 1818, *nomen confusum*. *F. gracillima* Smiley, Univ. Calif. Publ. Bot. 9: 143. 1921.

Bulb of few thin scales; stem 15–65 cm. long; leaves linear, 7 to 14, alternate to whorled, scattered, 6.25–8.75 cm. long, 1.5–4 mm. wide; flowers 1 to 4, or as many as 12, open campanulate, nodding, brown spotted with yellow and white; perianth segments rhomboid or oblong, tapering abruptly to the base, a tuft of yellow hairs at the apex, 9–21 mm. long, 2–8 mm. wide; gland an indistinct brownish-yellow area at base of segment; style cleft two-thirds to three-fourths its length; capsule 9–17 mm. long, acutely angled; flowering from April to July.

Distribution. Idaho to the Dakotas and Nebraska, south to New Mexico (*n.v.*), west to California and Oregon.

Type. "Flathead River, N. Rocky Mountains," *Nuttall*.

Representative material. OREGON. Grant County: Blue Mts., *Henderson* 5398. Harney County: Steins Mts., Sheep Camp, *Henderson* 8836. CALIFORNIA. Siskiyou County: Marble Mt., *Jepson* 2831. Trinity County: Scott Mts., north of Carrville, *Eastwood & Howell* 4989. Shasta County: Soupan Springs, *Hall & Babcock* 4304. Modoc County: Warner Mts., Lost Lake, *Schreiber* 1174. Plumas County: Portola, *Eastwood* 6992. Butte County: Humboldt Summit above Jonesville, *Owney & Ownbey* 1733. Placer County: Lake Tahoe, Deer, *Eastwood*, 407. Alpine County: Ebbett

Pass, *Beetle* 3778. Tuolumne County: Tuolumne Meadows, 1917, Miller. Mariposa County: Mormon Bar, Congdon. Fresno County: Pittman Creek, Grant 1061. Madera County: Yosemite Park, Mt. Lyell, Hall & Babcock 3562 (type of *F. gracillima*). Tulare County: Upper Marble Fork of Kaweah River, Hopping 312. IDAHO. Owyhee County: Silver City, Macbride 910. Lemhi County: Shoup, 1936, Blair. Custer County: Patterson, Hitchcock et al. 3757. Clark County: Spencer, Little Dry Creek Canyon, Rust 726. Bannock County: Pocatello, Donaghe 112. NEVADA. Washoe County: Verdi, 1899, Sonne. Elko County: Ruby Valley near Cave Creek Post Office, Mason 4705. White Pine County: Warm Springs, 1918, King. Clark County: Charleston Mts., Charleston Park, Rainbow Falls, Alexander 630. UTAH. Juab or Millard County: Fish Spring Mts., 1904, Jones. Iron County: Cedar City, Jones 5397W. Piute County: Marysville, Jones 3368. Kane County: Zion Park, 3 mi. east of east entrance, Hitchcock 2974. San Juan County: Navajo Mt., War God Spring, Benson 177. County uncertain: east central Utah, mouth of Green Canyon, Maguire & Burke 5150; Pharsolis Glenn, 1911, Clemens. ARIZONA. Coconino County: Grand Canyon of Colorado River, Grand View Hotel, Eastwood 5794. Gila County: Matzatzal Mts., North Peak, Collom 131. MONTANA. Gallatin County: Bozeman, Jones 54. WYOMING. Yellowstone Park, Glen Creek, Nelson 5612. Teton County: Grand Teton Park, Cascade Canyon, Williams 1137. Crook County: Hulett, Ownbey 591. COLORADO. Gunnison County: Gunnison watershed, Poverty Ridge near Cimarron, Baker 128. NORTH DAKOTA. McKenzie County: south part, T. 45, R. 102, 1938, Moran. SOUTH DAKOTA. Pennington County: near Deerfield, Palmer 37498. NEBRASKA. Dawes County: White River Valley near Bad Lands, on Eagle's Nest Butte, 1855, Hoyden.

Fritillaria alba is a *nomen confusum*. Nuttall's description is mainly that of a *Fritillaria*. The range given, however, lies far outside that of any species of *Fritillaria* except *F. atropurpurea* which the description does not fit. Ownbey attributes it in part to *Calochortus Nuttallii*.

17a. FRITILLARIA ATROPURPUREA var. PINETORUM (Davids.) Johnston, Plant World 22: 84. 1919. *F. pinetorum* Davids. Muhlenbergia 4: 67. 1908.

Bulb of thin scales and with rice-grain bulblets; stem 20–50 cm. long, usually stout; leaves 5–15 cm. long; 2–7 mm. wide; flowers 3 to 9, sometimes 11, mottled as in the species; segments 14–19 mm. long, 2–6 mm. wide; pedicels usually erect; capsule acutely angled, sometimes with short horn-like processes at base and summit of each valve; flowering from June to July.

Distribution. California from Alpine County to San Bernardino County, extending into Nevada; exposed slopes at 6000–10,500 feet elevation.

Type. California, Kern County, "Mt. Cummings, Tehachapi range," *Hasse & Davidson 1739*.

Representative material. CALIFORNIA. Alpine County: Carson Pass, *Eastwood & Howell 8423*. Mono County: Hot Springs, Casa Diablo, *Baker 9089*. Fresno County: North Fork of Kings River, Long Meadow, *Hall & Chandler 4421½*. Tulare County: Mt. Moses, *Purpus 1339*. Kern County: Greenhorn Mts., near Pine Flat, *Weston 679*. Ventura County: Mt. Pinos, *Munz 7029*. San Bernardino County: San Antonio Mts., Swarthout Canyon, *Hall 1507*.

EXCLUDED NAMES

Fritillaria alba Nutt. Gen. N. Am. Pl. 1: 222. 1818, *nomen confusum*.

Fritillaria barbata H.B.K. Nov. Gen. et Sp. Pl. 1: 288. 1816; *ibid.* 7: t. 677. 1825 = *Calochortus barbatus* Painter.

Fritillaria cuprea R. Graham, Edinb. New Phil. Jour. (Jan. 1836) 192 = *Calochortus barbatus* Painter.

Fritillaria linearis Coult. and Fisher, Bot. Gaz. 18: 352. 1892. Type probably from Black Hills of Dakota. The name of the collector has been lost and the type could not be located. No specimens answering to the description have since been collected.

Fritillaria purpurea H.B.K. Nov. Gen. et Sp. Pl. 1: 288. 1816 = *Calochortus purpureus* (H.B.K.) Baker.

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March, 1943.

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THE HOMONYM QUESTION

LEON CROIZAT

To close in a constructive vein the discussion about homonyms which has taken place in these pages, I owe the reader certain facts. Mr. A. Cronquist and Mr. C. A. Weatherby are correct in pointing out (*Madrono* 7: 83. 1943) that an earlier homonym—in the sense of Article 61 of the International Rules of Botanical Nomenclature—can be only a name which is validly published. Validity in publication, consequently, is essential to an homonym, for without it there is no homonymy.

This being the case, I point out that: (1) In the "Proposals of the British Botanists" (*Intern. Bot. Congr. Cambridge* 1930: 43. 1929) nothing is said about validity. (2) In the discussion that led to the adoption of Art. 61 (*Rept. Proc. Intern. Bot. Congr. Cambridge* 600-604, 1931) the discussion never touched upon the validity of an earlier homonym. (3) In her authoritative comment on the Cambridge Rules (*in Emp. For. Jour.* 10: 68. 1931) Miss M. L. Green said nothing about validity.

The meaning of an Article in the Rules is to be read in the text of the Article, which I will not deny. However, Art. 61 lays down validity as the fundamental requirement of homonymy. It is strange that this requirement should not be mentioned at all in the antecedents and comments written upon this Article. This omission should be understood in the light of the fact that meaningless or confusing additions are known to have been introduced into the Rules beyond the intentions of the proponents of certain Articles (*Croizat, Bull. Torrey Club* 70: 322. 1943).

It is evident, therefore, that by insisting upon validity of publication, Article 61 leaves completely unsettled the state of the legion of names commonly understood as *nomina subnuda*, *nomina abortiva*, and the like. The prime necessity of providing for these doubtful entities in nomenclature was quite clear to A. DeCandolle

(Lois. Nom. Bot., Art. 45, 46—Commentaires 45. 1867), and certainly was in the minds of those who wrote that Article 61 was intended to provide for names "published . . . with a description (or references to a former description)." By steering clear of the morass of what is *valid*, the Proposal just quoted was far better than Article 61 itself, which does not work in any case involving names of doubtful publication. It is not correct to state that validity and legitimacy are clear concepts. Without further entering into the matter, I may point out that Handel-Mazzetti proposed the outright cancellation of Article 61 (Fedde Rep. Sp. Nov. 46: 91. 1939) mainly on the ground that it was not clear in its definitions, and was ruinous in actual practice. I do not wholly agree with Handel-Mazzetti to the full, but his testimony, as such, is valuable here.

My very definite opinion was, and still is, that the adjective *valid* was not meant to be written in Article 61 and that for the good of taxonomy it should be removed. A formal proposal to this effect, with an appropriate discussion and examples, will be submitted to the Botanical Congress in due time.

Arnold Arboretum,
Jamaica Plain, Massachusetts,
August, 1943.

NOTES AND NEWS

A NEW NAME IN SCIRPUS. *Scirpus orbicephala* nom. nov. *Holoschoenus mexicanus* Palla, Oesterr. Bot.-Zeitschr. 63: 40. 1913. Not *Scirpus mexicanus* Clarke in Britton, Trans. N. Y. Acad. Sci. 11: 77. 1892. Subgenus *Euscirpus*. Section *Anosporum*. Mexico: Flor de Maria, *Pringle 3173*; Huerta, Loma Santa Maria, and Cerro Azul, *Arsenius*. Although described under the genus *Holoschoenus*, now a section of *Scirpus*, the species *H. mexicanus* Palla is recognized as belonging to the genus *Scirpus*, section *Anosporum*. A. A. BEETLE, Division of Agronomy, University of California, Davis.

Word was received on December 20, 1943, that Dr. W. Palmer Stockwell of the California Forest Experiment Station of the United States Forest Service had arrived in Lisbon, Portugal. With a representative of the Crown Cork and Seal Company, Dr. Stockwell expects to spend several months in the Mediterranean region. They will visit nurseries and plantations in Portugal, Spain, Spanish Morocco, Algiers and Tunisia in addition to making a study of the native habitat of the cork oak. In collaboration with the Crown Cork and Seal Company, the Forest Service plans to bring back several tons of seed from select cork oak trees and carry on further experimentation in this country in the hope of developing a successful cork oak industry here.

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THE TAXONOMY AND CYTOLOGY OF THE SUBGENUS
GORMANIA OF SEDUM

ROBERT T. CLAUSEN AND CHARLES H. UHL

INTRODUCTION

The species of *Sedum* comprising the subgenus *Gormania* seem to constitute a natural group in biological relationship. In geographical distribution, they are all restricted to the Pacific Mountain System of Western North America. Some of the principal points of this discussion appeared in a brief abstract in the American Journal of Botany (4). The detailed evidence for the statements made there are herein presented.

Historically, the species which we assign to the subgenus *Gormania* have had a troubled nomenclatural career. They have been referred variously to *Cotyledon*, *Echeveria*, *Gormania* and *Sedum*. The senior author (3) has already given his reasons for regarding this group of species as a subgenus of *Sedum*. Continued study and additional evidence have not altered this point of view. *Sedum spathulifolium* clearly belongs to the *Gormania* series, yet it is too close to typical *Sedum* to warrant generic segregation. Characters seem lacking by which it might be segregated from *Sedum* on a generic basis. Our data clearly indicate the alignment of *S. spathulifolium* with the true *Gormaniae*, yet it has petals distinct to the base, a detail also emphasized by Britton and Rose (2). *S. spathulifolium* affords a direct living connection between typical *Sedum* and the extreme types of section *Eugormania*. The separate petals of *S. spathulifolium* and the closely related *S. Purdyi*, usually regarded as an indication of morphological primitiveness, seem to strengthen the idea that these two species are less advanced phylogenetically than the other species of *Gormania*. They may be regarded as constituting a separate section from which *Eugormania* probably has evolved. It is interesting to note that *S. spathulifolium*, supposedly the most primitive species in the subgenus, is the most widely distributed; also, the other species all occur within its distributional area.

Three authors have rather recently accounted for the species which we place in subgenus *Gormania*. A comparison is interesting to show the differences in interpretation. Praeger (12), though considering only cultivated species, treated four of the binomials which we refer to subgenus *Gormania*. He assigned all of these to the section "*Seda Genuina*," group *Spathulifolia*, in which he also placed two other species. The six binomials, our disposition of them when we do not regard them as valid species, and the chromosome number for each, follow:

- S. spathulifolium* Hooker — $n = 15$, $2n = 30$
S. yosemitense Britton = a subspecies of *S. spathulifolium* —
 $n = 15$
S. rubroglaucum Praeger = *S. obtusatum* subsp. *typicum*
S. Hallii (Britton) Praeger = *S. obtusatum* subsp. *typicum* —
 $2n = 30$
S. oreganum Nuttall — $n = 12$
S. divergens S. Watson — $2n = ?16$

Berger (1) referred the species of *Gormaniana*, along with others, to two different groups of section "*Seda Genuina*." Below are listed all the species which he included in these groups, with those starred which we place in the subgenus *Gormaniana*.

Group 5. *Americana*

- S. longipes* Rose
S. filiferum S. Watson
S. Lumholtzii Robinson & Fernald
S. puberulum S. Watson = *S. Griffithsii* Rose
S. Wootonii Britton = *S. Cockerellii* Britton — $n = 16$
S. Griffithsii Rose — $n = 14$, 29
S. Wrightii A. Gray — $n = 12$, 36
S. Nevii A. Gray — $n = 6$
S. Nevii A. Gray var. *Beyrichianum* (Masters) Praeger
= *S. Beyrichianum* Masters — $n = 14$, 28
S. madrense S. Watson
**S. californicum* Britton = *S. spathulifolium* Hook.
S. bellum Rose
S. versadense Thompson
**S. Burnhamii* (Britton) Berger = *S. obtusatum* Gray subsp.
typicum — $2n = 30$
**S. laxum* (Britton) Berger = *S. laxum* subsp. *typicum* —
 $2n = 30$
**S. sanhedrinum* Berger = *S. laxum* subsp. *retusum*
**S. Eastwoodiae* (Britton) Berger = *S. laxum* subsp. *retusum*
— $2n = 30$

Group 23. *Rosulata*

- **S. spathulifolium* Hooker — $n = 15$, $2n = 30$
**S. pruinatum* Britton = a subspecies of *S. spathulifolium* —
 $n = 15$, $2n = 30$
**S. yosemitense* Britton = a subspecies of *S. spathulifolium* —
 $n = 15$
S. Leibergerii Britton
**S. Woodii* Britton = typical *S. spathulifolium* — $n = 15$
**S. Watsonii* (Britton) Berger = *S. oregonense* (Watson)
Peck — $2n = 90$
**S. obtusatum* A. Gray = *S. obtusatum* subsp. *typicum* — $2n = 30$
**S. Hallii* (Britton) Praeger = *S. obtusatum* subsp. *typicum* —
 $2n = 30$

S. debile S. Watson — $2n = 14-18$

S. oreganum Nutt. — $n = 12$

The various chromosome numbers which appear in the above lists are explained and discussed in a recent article in *Brittonia* (5).

Fröderström (8) recognized *Gormanina* as a separate genus, including in it *G. obtusata*, *G. Watsoni*, *G. anomala* and *G. rubro-glaucula*. He placed in two different groups of *Sedum*, under "*Americana Kyplocarpia*," other of the names which we refer to *Gormanina*. These are starred in the following lists.

Group *Ternatum*

S. ternatum Michx. — $2n = 16, 24, 32, 48$

S. Nevii A. Gray — $n = 6$

**S. californicum* Britton = a subspecies of *S. spathulifolium*

S. bellum Rose

Group *Spathulifolium*

**S. spathulifolium* Hooker — $n = 15$

**S. pruinosum* Britton = a subspecies of *S. spathulifolium* — $n = 15$

S. Leibergii Britton

**S. Woodii* Britton = typical *S. spathulifolium* — $n = 15$

**S. yosemitense* Britton = a subspecies of *S. spathulifolium* — $n = 15$

Our own arrangement follows:

Section 1. *Rosulata*

S. spathulifolium (including *S. anomalum*, *S. californicum*, *S. pruinosum*, *S. Woodii* and *S. yosemitense*) — $n = 15, 2n = 30$

S. Purdyi — $n = 15$

Section 2. *Eugormanina*

S. obtusatum — $n = 15, 2n = 30$

S. oregonense — $2n = 90$

S. laxum — $n = 15, 2n = 30$

S. Morani — $2n = 30$

Sedum oreganum, for which the senior author (3) created the section *Oreganica*, clearly does not belong to the *Gormanina* series. In habit, it is at once different, without prominent basal rosettes of leaves. Also, the petals are straight, not erect below and then spreading. Further, the chromosomes, though comparable in size with those of the species of subgenus *Gormanina*, exhibit a greater range in size among the members of the same complement. Also, the haploid number is 12. Probably *S. oreganum* should be dropped from subgenus *Gormanina* and referred to another subgenus of *Sedum*. Our data for this species are based on various living plants which originated in the state of Washington. The chromosome counts were made from collections of Professor W. C. Muenscher (7923 and 7929).

In the present work, the taxonomic study is by R. T. Clausen, the cytological investigation by C. H. Uhl. The collecting of plants for this study was made possible by grants from the Penrose Fund of the American Philosophical Society and the Trustee-Faculty Committee on Research of Cornell University. The cytological work was made possible by the grant from the Trustee-Faculty Committee. The plants in cultivation have been grown and maintained through the courtesy of the Department of Floriculture of Cornell University.

METHODS AND MATERIALS

We continue to employ the category of subspecies for the major morphological races of species which are geographically correlated because no really valid argument has yet been advanced against such usage. The criticisms by Fosberg (7) and Weatherby (13) fail to cope with the problem of horticultural varieties. Horticulturists continue to designate minor genetical variations of species, not geographically correlated, as varieties, ignoring the arguments of Fernald, Weatherby and Fosberg, who presumably would designate such variants as forms. For examples of the use of variety by tradesmen and horticulturists, see the 1943 catalog of W. Atlee Burpee Co. (pages 26, 27 *et al*) or the recent bulletin on grapes by Magoon and Snyder (11). The International Rules of Nomenclature do not outlaw subspecies for the groups which we so designate. On the other hand, a convincing argument can be constructed the other way. Most botanical and horticultural varieties are very minor genetic variations. These variations often are of great economic or horticultural significance, but phylogenetically are not yet important enough to be regarded either as species or subspecies. These should, in our opinion, be designated as varieties. They are numerous, really too numerous to warrant assigning botanical names to each, yet many have been named. Forms are the phenotypic variations of the same genotype. In *Sedum* they can frequently be produced by giving the plants more water than normal or by placing them in dense shade. They are usually physiological in origin and are best designated merely by descriptive vernacular terms.

The living plants which are the real basis for our classification were obtained for the most part in the summer of 1940 when Mr. Harold Trapido and the senior author collected extensively on the Pacific slope. Details of distribution have been obtained from a study of specimens in various herbaria. In the citations, names of these are abbreviated as: (BH) Bailey Hortorium, Ithaca, New York; (CAS) California Academy of Sciences, San Francisco; (CLOK) Clokey Herbarium at the University of California, Berkeley; (CU) Cornell University, Ithaca, New York; (DS) Dudley Herbarium, Stanford University, California; (FM) Field Museum of Natural History, Chicago Illinois; (NY) New

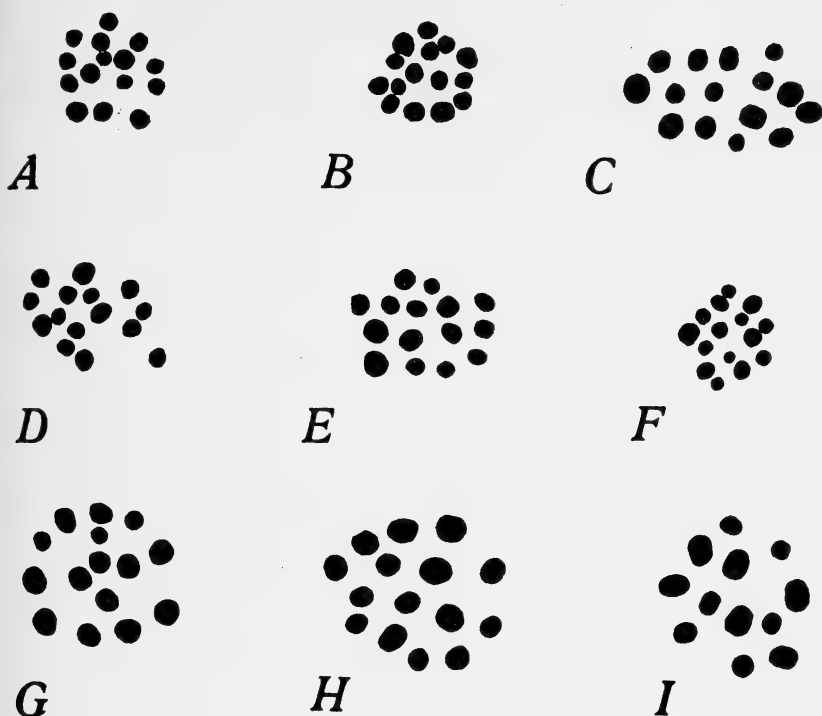


FIG. 1. Chromosome complements. *A*, *Sedum spathulifolium* subsp. *typicum*, from Josephine County, Oregon (C5010); fixed in craf, $n=15$. *B*, *S. s.* subsp. *typicum*, from Lake County, California (C4925); fixed in craf, $n=15$. *C*, *S. s.* subsp. *pruinsum*, from south of Crescent City, Del Norte County, California (C4937), $n=15$. *D*, *S. s.* subsp. *anomalum*, from San Bernardino Mountains, California (C4748), $n=15$. *E*, *S. s.* subsp. *anomalum*, from Yosemite National Park, California (C4802); second meiotic metaphase, $n=15$. *F*, *S. Purdyi*, from the canyon of Canyon Creek, Siskiyou County, California (C4983); fixed in craf, $n=15$. *G*, *S. laxum* subsp. *retusum*, from Mendocino County, California (UC28.3), $n=15$. *H*, *S. laxum* subsp. *typicum*, from Waldo, Oregon (C5018), $n=15$. *I*, *S. oreganum*, from Lummi Island, Whatcom County, Washington (WCM7925), $n=12$. Unless otherwise noted, all figures are first meiotic metaphases and fixation was in Carnoy's solution. All drawings are $\times 3320$.

York Botanical Garden, New York, New York; (ORE) University of Oregon, Eugene; (POM) Pomona College, Claremont, California; (UC) University of California, Berkeley; (US) United States National Herbarium, Washington, D. C. We wish to thank the curators at each of these institutions for making their specimens available for study.

The counts of chromosomes are from meiotic material. Most of the young flowers were fixed in Carnoy's fluid (6 parts chloroform, 3 parts absolute alcohol, and 1 part acetic acid), smeared, and stained in aceto-carmin. Some were fixed in craf, em-

bedded, sectioned, and stained in crystal violet. All preparations were examined with a Spencer microscope with 95 \times fluorite objective, N.A. 1.25. Drawings were made with a camera lucida, all $\times 3320$. The chromosomes, as well as metaphase plates, of material fixed in craf and stained in crystal violet were consistently smaller than those of material fixed in Carnoy's. This must be remembered in examining the figures. For purposes of comparison, the drawings, with one exception, are all of first meiotic metaphases.

CYTOLOGY

The details regarding chromosome number and morphology are reported under the various species and subspecies. Great similarity prevails throughout the whole subgenus. All species are $n = 15$, with the exception of *S. oregonense*, for which a $2n$ number of about 90 has been determined by Hollingshead (9). Comparison of the chromosome complements of eleven collections of *S. spathulifolium*, one of *S. Purdyi*, one of *S. laxum* subsp. *typicum* and one of *S. laxum* subsp. *retusum* indicate that these species can not be distinguished by their chromosomes. The chromosome complements are very similar, indicating close relationship between the two species of the section *Rosulata* and species of the section *Eugormania*. *Sedum oreganum*, with an n number of 12, seems remote from the species of *Gormania* and, as has already been suggested, should be dropped from this subgenus. Text figure 1 shows the chromosome complements in the various subspecies of *S. spathulifolium* and in *S. Purdyi*, *S. laxum* and *S. oreganum*.

SYSTEMATIC ACCOUNT

Gormania, as a subgenus, had its beginning in 1942. The key to the sections of the subgenus, in a recent paper by the senior author (3, pp. 28, 29), may now be emended as follows:

- | | |
|---|------------------------------|
| A. Petals separate to their bases, erect for about one-tenth of length, then widely spreading; rosettes with the leaves fleshy, but not leathery; inflorescence a 3-parted cyme, sometimes compound | 1. Section <i>Rosulata</i> |
| AA. Petals connivent or united for one-fourth or more of length, erect below, divergent above; rosettes with the leaves thick and leathery; inflorescence a paniculate cyme | 2. Section <i>Eugormania</i> |

Section *Rosulata* (Berger) Clausen et Uhl, stat. nov. Group *Rosulata* Berger, in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 18a: 457. 1930. Section *Rosulata* Clausen and Uhl, *nomen nudum*, Bull. Torrey Bot. Club 69: 27. 1942. Type species: *S. spathulifolium* Hooker.

Petals separate throughout their length, erect below for about one-tenth their length, then widely spreading; leaves arranged in prominent rosettes borne on creeping stems which give rise to

numerous secondary stems, likewise rosette-bearing; plants frequently producing large patches or mats which may spread for many years by vegetative means.

KEY TO THE SPECIES OF SECTION ROSULATA

- A. Rosettes loose, not densely compressed; leaves of rosettes loosely spreading, not closely compacted, minutely crenulate and papillose 1. *Sedum spathulifolium*
- AA. Rosettes densely compressed with the leaves closely compacted (pressed close together) and prominently papillate on margins 2. *Sedum Purdyi*

1. *SEDUM SPATHULIFOLIUM* Hooker

Perennial; sterile stems 1–3 mm. in diameter, 1–8.5 cm. long, white to pink or red, procumbent or creeping; leaves in prominent rosettes, usually spatulate, blunt or slightly emarginate, crenulate on margins, 0.3–3.2 cm. long, 2–14 mm. wide, 1–3 mm. thick, glaucous or pruinose or glabrous and dark- or yellow-green, sometimes suffused with red or bronze; primary stems usually with secondary offsets below rosettes and these sometimes with tertiary offsets; sterile shoots usually naked except for the rosette at the apex, but sometimes leafy throughout with alternate oblong-spatulate leaves, 0.5–1.5 cm. long; floral stems erect or decumbent, 5–30 cm. high, 1–4 mm. thick below inflorescence, with the leaves alternate, spatulate, oblong-spatulate, or elliptic-oblong, reduced downwards, 0.6–2.0 cm. long, 3–8 mm. wide; inflorescence a simple or compound three-parted cyme of 12–51 flowers, with a central flower; floral bracts oblong-spatulate, 4–11 mm. long; flowers sessile or short-stalked on pedicels 1–4 mm. long, usually 5-merous, 0.7–1.7 cm. in diameter; sepals lanceolate or ovate-lanceolate, connate below, 2–4 mm. long; petals lanceolate, acute, concave, 5–8 mm. long, erect below for 2–3 mm., then widely spreading, canary-yellow, rarely orange or white; stamens 4–5 mm. long, yellow; nectar scales 0.5 mm. long, 0.2 mm. wide, transversely oblong, deep yellow; pistils yellow-green, erect or divergent, but not widely spreading, 4–7 mm. long, with slender styles, 1.2–3 mm. long; seeds pyriform, reddish-brown, 1 mm. long.

This is at once the commonest and most widely distributed species of the subgenus *Gormanina*. It may be recognized by its creeping habit, its abundant rosettes of loosely arranged fleshy leaves and the three-parted cymes of yellow flowers with the petals distinct to the base.

Three subspecies may be distinguished. These differ primarily in vegetative characteristics. All have been transplanted from the wild to Ithaca, New York, where they have been grown under uniform conditions. Since they continue to maintain their distinctive characteristics after three years of culture, they seem

to be really different genetically, and not physiological variants. This conclusion is further supported by the fact that the three subspecies have different cultural requirements if one wishes to maintain each in optimum condition. The vegetative differences between the subspecies of *S. spathulifolium* and *S. Purdyi* are shown in plate 22, fig. 3.

KEY TO THE SUBSPECIES OF *SEDUM SPATHULIFOLIUM*

- A. Leaves of rosettes 2-3 mm. thick, very pruinose; rosettes 1.0-6.0 cm. in diam.; stems of offsets 1.5-3 mm. thick, frequently leafy throughout, but with a rosette-like cluster of leaves at the apex 1b. *S. spathulifolium* subsp. *pruinosum*
- AA. Leaves of rosettes green or glaucous, not decidedly pruinose, 1-2 mm. thick; rosettes 1-5 cm. in diam.; stems of offsets 1-2 mm. thick with the leaves usually restricted to the rosettes which are terminal on the shoots .. B
- B. Leaves glaucous, crenulate; stems of offsets 1.5-2 mm. in diam.; flowers 8-17 mm. in diam. 1a. *S. spathulifolium* subsp. *typicum*
- BB. Leaves green, usually neither glaucous nor pruinose, minutely crenulate; stems of offsets 1-1.5 mm. in diam.; flowers 7-11 mm. in diam. 1c. *S. spathulifolium* subsp. *anomalum*

1a. *SEDUM SPATHULIFOLIUM* Hooker subsp. *typicum*. *Sedum spathulifolium* Hooker, Flor. Bor. Am. 1: 227. 1834. *S. californicum* Britton, Bull. N. Y. Bot. Gard. 3: 44. 1903. *S. Woodii* Britton, No. Am. Flora 22: 73. 1905.

The distinctive features of subsp. *typicum* are the glaucous leaves, the more slender habit compared with subsp. *pruinsum*, and the slightly larger size compared with subsp. *anomalum*. These vegetative differences are well demonstrated by figure 3 (pl. 22). In floral characters, the subsp. *typicum* is likewise intermediate between the other two subspecies. The three-parted cymes usually contain from 20-40 flowers which are 8-17 mm. in diameter.

EXPLANATION OF THE FIGURES. PLATE 22.

PLATE 22. HABIT STUDIES OF SPECIES OF *SEDUM* IN THE SUBGENUS *GORMANIA*. FIG. 1. *Sedum spathulifolium* subsp. *typicum*, cultivated in greenhouse at Ithaca; collected along Grave Creek, Josephine County, Oregon. Photo by W. R. Fisher. FIG. 2. *Sedum spathulifolium* subsp. *pruinsum*, on rocks along Pacific Ocean, south of Crescent City, California. Photo by Harold Trapido. FIG. 3. Rosettes cultivated in greenhouse at Ithaca: a, *Sedum Purdyi*, from canyon of Canyon Creek, Siskiyou County, California; b, *Sedum spathulifolium* subsp. *pruinsum*, from rocks along Pacific Ocean south of Crescent City, California; c, *Sedum spathulifolium* subsp. *anomalum*, from Yosemite National Park, California; d, *Sedum spathulifolium* subsp. *typicum*, from Josephine County, Oregon. Photo by W. R. Fisher. FIG. 4. Type collection of *Sedum spathulifolium* subsp. *pruinsum* var. "Cape Blanco," cultivated at Ithaca. Photo by W. R. Fisher.

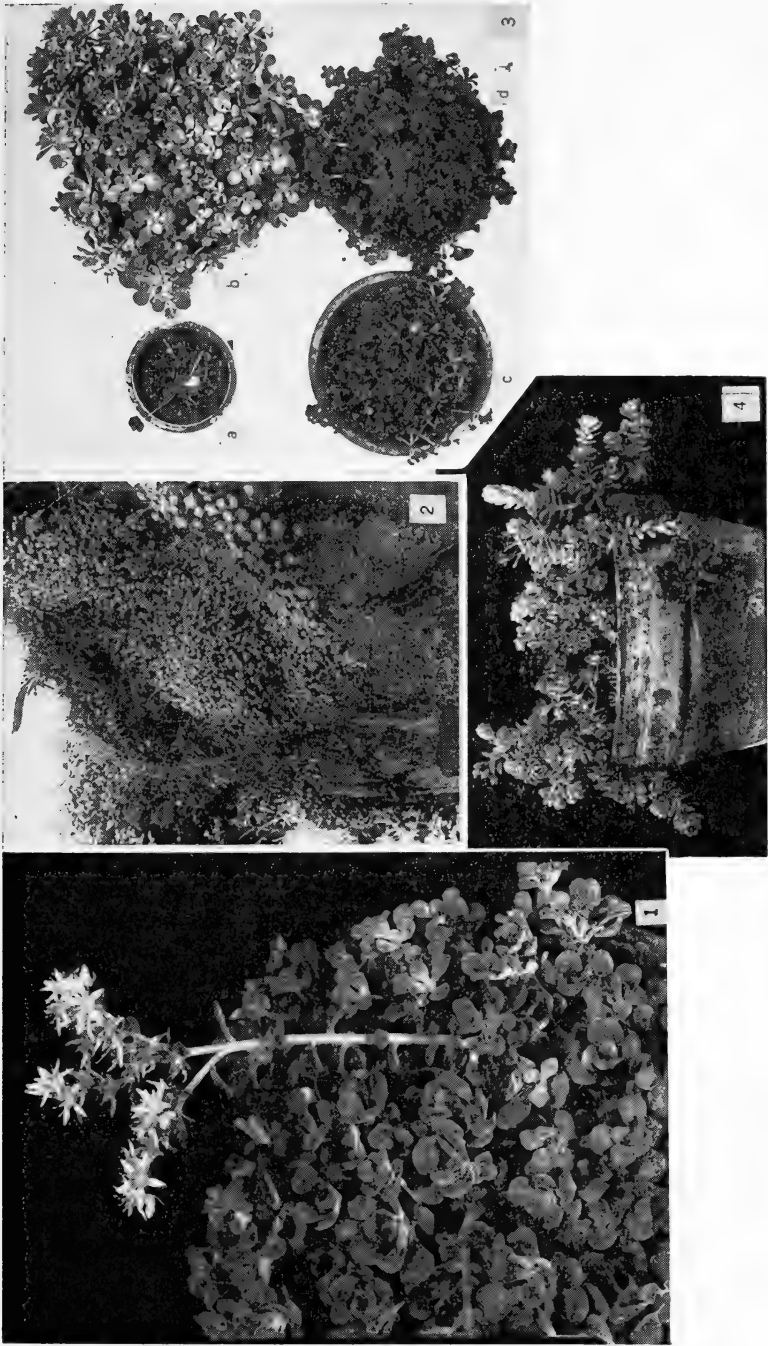


PLATE 22. HABIT STUDIES OF SPECIES OF SEDUM IN THE SUBGENUS GORMANIA.

The subsp. *typicum* is widely distributed in the northern Coast Ranges, the Cascade Mountains and the northern part of the Sierra Nevada. It occurs from the lower Bella Coola and Fraser

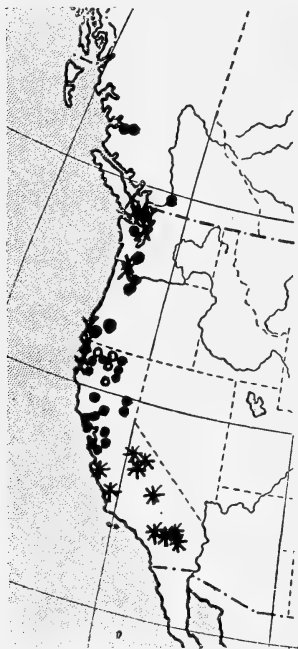


FIG. 2. Map showing distribution of the species and subspecies of the section *Rosulata* of *Sedum*: ● = *S. spathulifolium* subsp. *typicum*; × = *S. s.* subsp. *pruinatum*; * = *S. s.* subsp. *anomalum*; ○ = *S. Purdyi*.

River valleys in British Columbia, to the Santa Cruz Peninsula in California. The altitudinal range is from 92 to 1920 meters. Since most of the specimens examined are without information about altitude, it is likely that this range will be increased as more data become available. The subsp. *typicum* usually grows in rocky places in ravines and canyons and on steep slopes.

Specimens seen. Highest altitude: 1920 m., 3 km. east of White Mt., Siskiyou Mts., Siskiyou Co., Calif., *Wheeler 3171* (NY); lowest altitude: 92 m., 3 km. south of Oregon City, Clackamas Co., Ore., *Clausen* and *Trapido 4925* (CU); northernmost: 52°30' N., Burnt Ridge Creek, 50 km. east of Bella Coola, Skeena Co., B. C., *McCabe 1510* (UC) (Since the dried specimens are poor, their identity is questionable. This occurrence should be checked by further collections); easternmost: 120° W., Emigrant Gap, Calif., *Jones 3345* (CLOCK, NY); westernmost: 124° W., Snow Camp Lookout, Curry Co., Ore., *Leach 2292* (ORE); southernmost: 37°30' N., Los Gatos Cañon near Los Gatos, Santa Clara Co., Calif., *Heller 7422* (FM, UC); oldest: Sept. 25, 1861, summit of Mt. Diablo, Calif., *Brewer 842* (UC); type: not seen (collected by

Douglas on dry rocks of the Columbia and Salmon rivers); types of names assigned to synonymy: north side of Mount Shasta, Siskiyou Co., California, alt. 5000–9000 ft., June 11–16, 1897, *Brown 336* (type of *S. californicum* Britton, NY); Oregon City, Oregon, 1866, *Wood* (type of *S. Woodii* Britton, NY). Number of collections seen: 63. Specimens of this subspecies examined in connection with the present study have been annotated as *Sedum spathulifolium* Hooker, subspecies A.

Hooker described *Sedum spathulifolium* as common on dry rocks of the Columbia and Salmon rivers. His description is not sufficiently complete to make positively certain which of the subspecies he was describing. Our basis for interpretation of the name rests on the plants which are the prevalent kind in the valley of the Columbia River. We have seen no specimens from

as far inland as the Salmon River. The type specimen of *S. californicum* looks like typical *S. spathulifolium*, but the leaves are pruinose in the dried condition and Britton described the petals as white. Possibly the color of the flowers may have faded, as sometimes happens. Cooke, in a letter of January 13, 1941, and in a publication (6), questioned whether the specimens of *S. californicum* and other of Brown's collections really originated on Mt. Shasta. He favored the idea that they came from the eastern ridges or ranges of the Klamath Province. According to Cooke, A. A. Heller who knew Brown personally, wrote that no doubt all of Brown's *Sedum* collections were made somewhere on Mt. Eddy. As far as we understand the present distribution of these plants, this theory impresses us as reasonable, particularly since Cooke has been unable to find the plant on the north side of Mt. Shasta, and Trapido and the senior writer were likewise unsuccessful in their search there in 1940. At Oregon City, the type locality of *S. Woodii*, Trapido and the senior writer found *S. spathulifolium* frequent on rocks, but plants from there do not seem distinctive.

The time of flowering and fruiting depends somewhat on the latitude and on the altitude. Extreme dates of flowering for three districts, as determined from data with herbarium specimens, are:

Santa Cruz Peninsula, Calif. . . .	April 28-May 28
Western Oregon	May 9-June 24
Fraser River Valley, B. C.	June 15-July 15

A dwarf variety, collected originally at 1524 meters, at Snow Camp Lookout in Curry Co., Ore., has been designated by HENDERSON (in M. E. Peck, Man. High. Plants Oregon. p. 360. 1941) as var. *minus*. This may interest horticulturists and should be listed as a variety under subsp. *typicum*. The type is in the herbarium of the University of Oregon. Praeger's var. *purpureum* should be referred to subsp. *pruinoseum* and his var. *majus* to subsp. *anomalum*, though both these varieties have in the past been placed under typical *S. spathulifolium*.

Plants of six collections have been studied cytologically. All are $n = 15$. Previously, Hollingshead (9) had reported a diploid number of 30 for three of the collections of *S. spathulifolium*. Collections for which the euploid number is now reported are: Clausen and Trapido 4925, South Fork of Eel River, 8 km. west of Hullville, Lake Co., Calif.; Clausen and Trapido 5010, north side of Grave Creek, 1.4 km. east of junction with Rogue River, Josephine Co., Ore.; Clausen and Trapido 5022, bluffs along east side of Willamette River, 3 km. south of Oregon City, Clackamas Co., Ore.; and Clausen 77, 141 and 324, all from cultivated sources. The chromosome complements of these several collections are sufficiently similar that one collection cannot be separated from another on a basis of the chromosomes. There is some variation

in the size of the chromosomes in a complement, but none of the chromosomes are sufficiently distinctive to be identified.

Sedum spathulifolium subsp. *typicum* is frequent in the horticultural trade. It is grown in rock gardens and is usually correctly named as to species. Rarely it is listed as *S. Woodii*. The var. *minus* also is offered. Other varieties are listed, but these are either referable to other subspecies or are *nomina nuda*.

The first illustration of typical *S. spathulifolium* seems to have been published in 1888 in the Garden (vol. 24, page 462). An earlier plate which appeared in Gartenflora in 1872 is so poor that there is doubt whether the plant figured really is *S. spathulifolium*.

1b. *SEDUM SPATHULIFOLIUM* Hooker subsp. *pruinoseum* (Britton) Clausen et Uhl, comb. nov. *Sedum pruinoseum* Britton, No. Am. Flora 22: 72. 1905.

The distinctive characteristics of subsp. *pruinoseum* are the very pruinose condition of the leaves, stems, floral bracts and calyx; the large size, with the leaves of the rosettes 2–3 mm. thick; and the stout sterile stems, 1.5–3 mm. thick, which are frequently leafy throughout, whereas in the other two subspecies the leaves usually occur only in dense rosettes at the ends of the shoots. In cultivation at Ithaca, subsp. *pruinoseum* maintains its distinctive characteristics and thrives more successfully than do either of the other two subspecies. Also it seems to prefer more moisture. Whereas subsp. *anomaleum* scarcely persists under the same conditions of culture, subsp. *pruinoseum* becomes robust, flowers and spreads.

The subsp. *pruinoseum* is restricted almost entirely to rocks and bluffs along the Pacific Ocean from near Little River, Humboldt County, California, to Nanaimo on Vancouver Island. In the "Preliminary Catalogue of the Flora of Vancouver and Queen Charlotte Islands" (10), the report of *Sedum spathulifolium* from the Queen Charlotte Islands may refer to subsp. *pruinoseum*, but we have not seen specimens from there. The altitudinal range is not great, essentially from sea-level to about 30 meters or perhaps a little higher. The plants trail, creep or even hang over the boulders along the coast, often forming great patches or mats on the rocks. They must frequently be bathed in the spray of the surf. Two collections from along the lower course of the Columbia River and several from the islands of Puget Sound suggest that this population is connected with the population of subsp. *typicum* of inland districts by specimens somewhat intermediate in character and should not be segregated as a separate species. This opinion must yet be checked by genetical experiments.

Specimens seen. Highest altitude: 30 m., coast bluffs near Trinidad, Humboldt Co., Calif., *Tracy* 2582 (UC); lowest altitude: 3 m., 8 km. south of Crescent City, Del Norte Co., Calif., *Clausen* and *Trapido* 4937 (BH, CU, NY, US); northernmost: 49°10' N., Nanaimo, *Rosendahl* 1886 (CLOK); easternmost:

122°30' W., Lummi Island, Whatcom Co., Wash., *Muenschner* 7930 (CU); westernmost: 124°10' W., Gold Beach, Curry Co., Ore., *Hoyt* 64 (DS); southernmost: 41°2' N., south of Little River, Humboldt Co., Calif., *Wiggins* 5878 (FM, UC); oldest: 1887, Cedar Hill, Vancouver Island, B. C., *Macoun* (NY); type: Crescent City, California, 1903, *Eastwood* (NY). Number of collections seen: 32. Specimens of this subspecies, examined in connection with the present study, have been annotated as *Sedum spathulifolium* Hooker, subspecies B.

Miss Eastwood sent Dr. Britton a fresh piece of her original collection. This was cultivated in New York and flowered there on May 8, 1904 (N. Y. Bot. Gard. no. 18748, *Rose* 540). The type appears pruinose and consists of two floral stems, plus a few leaves. There are really no good rosettes on the specimen. Living plants and herbarium specimens collected by Trapido and the senior writer on cliffs and ledges along the shore of the Pacific Ocean 8 km. south of Crescent City, on July 24, 1940 (*Clausen* and *Trapido* 4937) are good matches for the type of *S. pruinoseum* and have been our basis for interpretation of the name.

Extreme dates of flowering are April 27 and July 24. The flowering period is more prolonged than in subsp. *typicum*, also it is earlier at any given latitude. Undoubtedly this feature may be explained, at least partly, on a basis of the lower altitude at which subsp. *pruinoseum* occurs and the consequent milder climate.

Principal variations are in the color of the leaves and stems and in size. Praeger (12, p. 239) has described a var. *purpureum* with the leaves purple. We have grown this in Ithaca, having obtained specimens from two different horticultural sources. The plants are definitely referable to subsp. *pruinoseum*, under which the variety should be listed. At least two other unpublished varietal names, likewise referable to subsp. *pruinoseum*, are also in the trade.

Plants of two collections have been studied cytologically: *W. C. Muenschner* 7930 from Lummi Island, Washington; and *Clausen* and *Trapido* 4937 from Crescent City, California. Both collections are $n = 15$. Previously, Hollingshead (9) had reported $2n = 30$ in root-tips of the *Muenschner* collection (7930).

The subsp. *pruinoseum* is probably as common in the horticultural trade as subsp. *typicum*, but it is usually offered as *S. spathulifolium*. Rarely it is listed as *S. pruinoseum*. The var. *purpureum* is available under that or other varietal names indicating reddish foliage. This subspecies is definitely to be recommended for culture by eastern gardeners. Particularly desirable are plants of the type which probably originated at Cape Blanco in Oregon. We now name this as *Sedum spathulifolium* subsp. *pruinoseum* var. "Cape Blanco" var. nov. Hort., with the rosettes 1–2 cm. in diam., usually densely crowded, and with the leaves small, convex dorsally and ascending. As type we designate the specimen (*S* 266),

cultivated at Cornell University, Ithaca, which is shown in figure 4 (pl. 22).

Figure 2 (pl. 22) shows the habit of the plant in nature. A drawing of a flowering plant, probably to be identified as this subspecies, appeared in *Gardeners Chronicle* in 1876 (vol. 5, p. 821).

1c. *SEDUM SPATHULIFOLIUM* Hooker subsp. *anomalum* (Britton) Clausen et Uhl, comb. nov. *Gormaniana anomala* Britton, Bull. N. Y. Bot. Gard. 3: 30. 1903. *Sedum yosemitense* Britton, *ibid.*, p. 44. *S. anomalum* (Britton) Britton, No. Am. Flora 22: 72. 1905.

The most distinctive characteristic of *Sedum spathulifolium* subsp. *anomalum*, when seen in the field, is the non-glaucous condition of the leaves. This feature is likewise exhibited by cultivated specimens, whereas plants of the other two subspecies, when grown side by side with subsp. *anomalum*, under the same circumstances, exhibit the glaucous or pruinose condition. Another feature of subsp. *anomalum* is the usually smaller size, with the rosettes rarely more than 2.5 cm. in diameter. For the most part, the stems of the offsets are rather slender, 1–1.5 mm. in diameter.

The subsp. *anomalum*, found only in California, ranges along the west slope of the Sierra Nevada, from the region of Yosemite National Park southward to the San Bernardino and San Gabriel mountains. Along the coast it extends as far north as the headwaters of the Carmel River. It has been collected most frequently in the Sierra Nevada and the San Bernardino and San Gabriel mountains. The altitudinal range is from a little above sea-level to 2286 meters. The usual habitats are rocky slopes and hillsides, ravines and ledges.

Specimens seen. CALIFORNIA. Highest altitude: 2286 meters, San Bernardino Mts., Crawford 911 (POM); lowest altitude: 30 m. \pm ?, Gragg's Canyon, San Luis Obispo Co., Moran 421 (BH); northernmost: 37°50' N., Hetch Hetchy Valley, Yosemite National Park, Hall and Babcock 3380 (UC); easternmost: 117° W., Bear Creek, San Bernardino Mts., Pierce (UC); westernmost: 121°30', Pine Valley, head of Carmel River, Goldman 762 (FM); southernmost: 34°2' N., pipe line trail on Yucaipa Mts., Reed 2769 (UC); oldest: 1865, Yosemite Valley and Mts., Torrey (NY); type: sandy hills in the path of strong daily sea winds, San Luis Obispo Co., June, 1883, Summers (NY); type of *Sedum yosemitense* Britton (NY), assigned to synonymy: Yosemite Valley between Vernal and Nevada Falls, 1677 m., July, 1902, Hall and Babcock 3425. Number of collections seen: 33. Specimens of this subspecies, examined in connection with the present study, have been annotated as *Sedum spathulifolium* Hooker, subspecies C.

A collection from the San Bernardino Mountains (Clausen and Trapido 4748), is a reasonable match for the type of Britton's

Gormania anomala and has been used by us as a standard in our comparison of living plants. A specimen from the type locality of *S. yosemitense*, in Yosemite Valley below Nevada Falls (*Clausen* and *Trapido* 4802), is a good match for the type of that species. Plants of the collections cited above (4802 and 4748), when grown under uniform conditions at Ithaca, became very similar and had the same cultural requirements. There seemed to be no real differences between these plants.

May and June are the principal months of flowering. Extreme dates when flowering specimens have been collected are April 30 and July 4, with one record of it being found in flower in the San Bernardino Mountains in November.

Two varieties of subsp. *anomalum* occur, one with white flowers and the other with the whole plant larger in size. The latter has been named var. *majus* by Praeger (12, p. 238). Our basis for referring it to subsp. *anomalum* rests on the fact that the leaves are green, not glaucous. Large specimens, similar to what Praeger has described, have been seen in the Santa Barbara Botanic Garden. These came originally from San Luis Obispo County and were collected by Reid V. Moran. This is the region of the type locality, but other plants from there were not nearly so large. It is possible that variety *majus* is only a physiological form, a response to richer soils, shade and increased moisture. If further collections from San Luis Obispo County should reveal that most of the plants from there are large and perhaps slightly glaucous, then *Gormania anomala* may need to be referred to subsp. *typicum* and the name *yosemitense* used for the subspecies of the Sierra Nevada and the San Bernardino and San Gabriel mountains.

Two collections, studied cytologically, are $n = 15$. These are from Cascade Canyon, San Gabriel Mountains, California (*Clausen* and *Trapido* 4748), and from below Nevada Falls, Yosemite Valley, California (*Clausen* and *Trapido* 4802).

Subspecies *anomalum* is rare in the horticultural trade. Judging from experience in growing it at Ithaca, it is difficult to maintain and less desirable than either of the other two subspecies.

Praeger's (12) illustration of *S. yosemitense* shows fairly well the aspect of subsp. *anomalum*.

2. SEDUM PURDYI Jepson, Fl. Calif. 2: 110. 1936.

Perennial with the stems procumbent or creeping, bearing flat rosettes of spatulate leaves; stems 1-4 mm. in diameter, 4-7 cm. long, light green to brown; leaves of rosettes closely imbricated with their apices pressed close together, spatulate or orbicular-spatulate, rounded or truncate at apex, papillose on margins, 0.1-1.8 cm. long, 1-10 mm. wide, 1 mm. thick, yellow-green, granulose ventrally, waxy dorsally, sometimes lustrous; primary stems with offsets below rosettes, these radiating like the spokes of a wheel and naked except for the rosettes at their apices, 1.5-7 cm. long, green; floral stems erect or slightly decumbent, 0-16

cm. high, 2–3 mm. thick below the inflorescence, with the leaves alternate, oblong-spatulate, spreading, 0.3–1.5 cm. long, 1–4 mm. wide; inflorescence a three-parted cyme of 10 to 39 flowers, with a central flower; floral bracts oblong-spatulate to linear, 2.5–5 mm. long; flowers sessile or short-stalked on pedicels to 2 mm. long, usually 5-merous, 1.5 cm. in diameter; sepals linear-lanceolate, obtuse or subacute, green, 2–2.5 mm. long; petals lanceolate, acute, 5–7 mm. long, spreading above the base, bright yellow to white; stamens 4 mm. long, anthers yellow or white; nectar scales 0.8 mm. long, 0.5 mm. wide, transversely oblong; pistils erect or divergent, gibbous ventrally, 4–7 mm. long, with the styles 1–2 mm. long; seeds pyriform, yellowish-brown, 0.8 mm. long.

The present known range of *Sedum Purdyi* is in the southern portion of the Klamath Mountains in northern California. We have seen specimens from altitudes of 183 to 617 meters, but Jepson mentioned the upper limit of altitudinal range as 4000 feet (1219 meters). The usual habitats are ledges and rocky slopes in shaded situations.

Specimens seen. CALIFORNIA. Highest altitude: 617 meters, east side of corral of Canyon Creek Camp, 1.6 km. up Canyon Creek from Scott River, 19 km. south of Hamburg, Siskiyou Co., *Clausen* and *Trapido* 4983 (CU); lowest altitude: 183 meters, Somes Bar, Siskiyou Co., *Tracy* 16271 (UC); northernmost: 41°36' N., same as highest altitude; easternmost: 122°40' W., near French Gulch, Shasta Co., *Rose* (CAS) (Jepson has cited the easternmost locality as Kennett, but we have seen no specimens from there); westernmost: 123°30' W., same as lowest altitude; southernmost: 40°42' N., same as easternmost; oldest: Aug. 21, 1908, Etna Creek, Siskiyou Co., *Butler* 498 (CAS, UC); type: not seen (Etna Mills, Calif., Carl Purdy). Number of collections seen: 7.

A collection from ridges along Canyon Creek, Siskiyou County, California (*Clausen* and *Trapido* 4983) agrees for the most part with characters given in the original description of *S. Purdyi* and matches specimens from Mr. Purdy's nursery. This collection has been our basis for interpretation of the species. The rosettes are flat with the leaves closely compressed; the margins of the leaves are prominently papillose; and the petals are yellow, not white as stated in the original description. For directions to the locality at Canyon Creek, the senior writer wishes to express his gratitude to Mr. J. T. Howell of the California Academy of Sciences.

The flowering time is late in April. Flowering dates obtained from herbarium specimens are April 23 and April 29. Fruiting specimens with ripe seeds have been collected in late July. Plants obtained in flower in the Marble Mountains in August were probably blooming abnormally, since the usual time seems to be in the spring.

No noteworthy variations of *Sedum Purdyi* have come to our attention. The species seems nearest to the subsp. *anomalum* of *S. spathulifolium* and, like that, is difficult to grow in the eastern part of the continent. Some specimens of the subsp. *anomalum* have appeared so similar to *S. Purdyi* that we have had difficulty in separating them, but usually the rosettes of *S. Purdyi* are more compressed and the margins of the leaves are more prominently papillose.

Plants of the collection from Canyon Creek Camp, cited above (Clausen and Trapido 4983), have been studied cytologically. These are $n = 15$.

Sedum Purdyi is occasionally offered in the horticultural trade and is usually correctly named.

Figure 3 (pl. 22) shows rosettes of the three subspecies of *S. spathulifolium* and of *S. Purdyi*. Note the slender stems of the secondary rosettes of the latter species.

SECTION EUGORMANIA CLAUSEN

Gormaniana Britton, Bull. N. Y. Bot. Gard. 3: 29. 1903. Named in honor of M. W. Gorman of Portland, Oregon. Type species: *Cotyledon oregonensis* Watson (*Sedum oregonense*).

A detailed discussion of this section has already appeared in print (3). For convenience, the key to species and the keys to the subspecies of *S. obtusatum* and *S. laxum*, with slight emendation, are repeated here. Otherwise, data are presented only when they are supplementary to the information in the earlier paper.

KEY TO THE SPECIES OF EUGORMANIA

- | | |
|--|----------------------------|
| A. Inflorescence and upper part of stem glandular pubescent, strongly reflexed before flowering time; leaves of rosettes glandular-ciliate; petals yellow | 6. <i>Sedum Moranii</i> |
| AA. Inflorescence and upper part of stem glabrous, usually erect before flowering time; leaves of rosettes usually not ciliate; petals yellow, white or pink | B |
| B. Flowers yellow or pale yellow, sometimes fading to white or pink in age; inflorescence a panicle cyme; leaves of rosettes 1-3.5 cm. long | 3. <i>Sedum obtusatum</i> |
| BB. Flowers white, creamy white or pink; inflorescence a dense panicle cyme or corymbose cyme; leaves of rosettes 1-4.5 cm. long ... | C |
| C. Flowers white or creamy white; sepals ovate, 2-3 mm. long | 4. <i>Sedum oregonense</i> |
| CC. Flowers pink or pale pink, rarely white; sepals lanceolate or ovate, 2-5 mm. long | 5. <i>Sedum laxum</i> |

3. SEDUM OBTUSATUM A. Gray

Mr. Jack Whitehead has sent some large specimens collected originally by Mr. George B. Youngs from along the North Fork

of the Feather River, 4 km. north of Belden, Plumas County, California, and at an altitude of about 915 meters. These are characterized by very large rosette-leaves, up to 5 cm. long. The petals are pale yellow. These plants seem referable to *S. obtusatum*, but match neither subsp. *typicum* nor subsp. *boreale*. It is possible that they may represent an undescribed subspecies, since no material has previously been available from the Feather River region. One might expect that *Sedum obtusatum* from that section would be intermediate between the two described subspecies, but samples of the plants obtained by Mr. Youngs are larger than either of the other two races.

KEY TO THE SUBSPECIES OF *SEDUM OBTUSATUM*

- A. Basal leaves relatively small, 0.5–2.5 cm. long, usually broadly rounded or truncate at apex; stems of rosettes bright red 3a. *S. obtusatum*
subsp. *typicum*
- AA. Basal leaves usually larger, 1–3.5 cm. long, usually retuse at apex; stems of rosettes pale red or pink 3b. *S. obtusatum*
subsp. *boreale*

3a. *SEDUM OBTUSATUM* A. Gray subsp. *TYPICUM*.

No new data have accumulated regarding this subspecies.

3b. *SEDUM OBTUSATUM* A. Gray subsp. *BOREALE* Clausen.

A plant of the type collection (Clausen, Trapido and Cooke 4952) flowered in a greenhouse at Ithaca on May 7, 1943. The stamens were red and the carpels were suffused with red. The petals spread rather widely above the middle. The length of the basal leaves ranges up to 3.5 cm. long.

The senior writer wishes to express hearty thanks to W. B. Cooke for guiding him and Mr. Trapido to the locality on Mt. Shasta where subsp. *boreale* occurs.

4. *SEDUM OREGONENSE* (Watson) M. E. Peck.

The inflorescence is a paniculate cyme, not a true panicle. A plant, originally from Crater Lake, which flowered indoors at Ithaca, had yellow anthers.

5. *SEDUM LAXUM* (Britton) Berger.

Further study of living plants in cultivation necessitates a few changes in the key to the subspecies.

KEY TO THE SUBSPECIES OF *SEDUM LAXUM*

- A. Plants tall and robust, 25–45 cm. high; leaves dark green to glaucous; stems of sterile rosettes pink, 4–6 cm. long; petals pale to deep pink 5b. *S. laxum*
subsp. *typicum*

- AA. Plants not as tall as above, 10–25 cm. high; leaves yellow-green or blue-green, usually glaucous; petals pink, pale pink to white suffused with pink B
- B. Inflorescence congested; rosettes closely crowded, forming a dense mat, with the leaves rather thin; stems of sterile rosettes green to black, 1.5–2 cm. long 5d. *S. laxum*
subsp. *retusum*
- BB. Inflorescence lax; rosettes not closely crowded, forming a loose mat, with the leaves thick and leathery C
- C. Rosette-leaves very broad, 2.0–3.0 cm. wide, triangular, obcordate, sometimes not glaucous; petals pale pink to white 5c. *S. laxum*
subsp. *latifolium*
- CC. Rosette-leaves narrow, 0.3–2.0 cm. wide, oblong-ob lanceolate or spatulate, usually glaucous; petals pink D
- D. Cauline leaves oblong-spatulate, longer than broad 5a. *S. laxum*
subsp. *perplexum*
- DD. Cauline leaves cordate to subcordate, about as broad as long 5e. *S. laxum*
subsp. *heckneri*

5a. *SEDUM LAXUM* (Britton) Berger subsp. *PERPLEXUM* Clausen.
No new data have come to hand.

5b. *SEDUM LAXUM* (Britton) Berger subsp. *TYPICUM*. Cultivated specimens originally from the type locality exhibit some variation in the glaucous condition of the leaves. Some rosettes are less glaucous than others. A collection of Clausen (5018) is $n = 15$. Previously, Dr. Hollingshead had reported a diploid number of 30 for this same collection. A cultivated plant, received as *Sedum Jepsoni*, is *Sedum laxum* subsp. *typicum*. That binomial was introduced into the literature by H. M. Butterfield (Desert Plant Life 8: 7. 1936).

5c. *SEDUM LAXUM* (Britton) Berger subsp. *LATIFOLIUM* Clausen. A specimen of the type collection, cultivated in a greenhouse at Ithaca, flowered in the spring of 1943. The inflorescence was 15 cm. long and 6 cm. wide. The stamens were 6–7 cm. long with the anthers red and the filaments white to pink. The pistils were 8 mm. long with the ovaries green and the styles and stigmas pink.

5d. *SEDUM LAXUM* (Britton) Berger subsp. *RETUSUM* (Rose) Clausen. Two additional years of culture of this subspecies have not affected its characteristic manner of growth. Cytological study of University of California no. 28.3 from Mendocino County, California, indicates that the haploid number is 15.

5e. *SEDUM LAXUM* (Britton) Berger subsp. *HECKNERI* (Peck) Clausen. No new data have become available regarding this subspecies.

6. *SEDUM MORANII* Clausen. No new localities for this rare species have come to our attention.

SUMMARY

The subgenus *Gormania* of *Sedum* includes six species which together constitute a natural phylogenetic group restricted to the Pacific Mountain System of Western North America. Taxonomic, geographical and cytological data all confirm this opinion. The chromosome number, with one exception, is $n = 15$, $2n = 30$. The exception is *S. oregonense*, of which the only plants so far studied are hexaploid. The species may be grouped in two sections, *Rosulata* and *Eugormania*, the former the more primitive. The section *Oreganica*, based on *Sedum oreganum*, does not belong in *Gormania* and should be referred elsewhere. The section *Rosulata* includes two species, *S. spathulifolium* and *S. Purdyi*. The section *Eugormania* includes the other four species: *S. obtusatum*, *S. oregonense*, *S. laxum* and *S. Moranii*. New botanical names are *S. spathulifolium* subsp. *pruinatum* and *S. s.* subsp. *anomalum*. A possibly undescribed subspecies of *S. obtusatum* is mentioned from the Feather River region in Plumas County, California.

Department of Botany,
Cornell University, Ithaca, New York,
July, 1943.

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J. W. STACEY, CARICOLOGIST

JOHN THOMAS HOWELL

That Mr. J. W. Stacey should have studied western carices was inevitable. His interest in this difficult group had been aroused years before by Charles Fay Wheeler when he was scarcely more than a lad in the Middle West and under Wheeler he made his first studies. For all the years that he had lived in San Francisco, systematic botany had been his chief interest outside of his business and the Glumiflorae had been more attractive to him than any other group. Hence, in 1933, when Miss Eastwood asked her long-time friend to determine for her a formidable accumulation of carices which K. K. Mackenzie had just declined to examine because of ill health, Mr. Stacey gladly consented. A concurrent reorganization of his business allowed him more time to himself and it was not long before he was deeply engrossed in a study of *Carex* in Western North America with ambitious plans for a revision of the genus in the United States west of the Rocky Mountains. Thus this chain of events brought to Western Botany its only resident caricologist and centered his work at the California Academy of Sciences. For five years he pursued his systematic studies intensively but, due to a heart ailment which finally prevented the use of the microscope, he was unable to continue after 1939. Not only did Mr. Stacey contribute a great deal to our knowledge of western *Carex* but in this often-neglected genus he awakened a widespread interest among field workers that for many years will attest the influence of his vital and infectious enthusiasm.

Mr. Stacey was fundamentally interested in species and favored all means for detecting them, whether by morphology, cytology, or physiology. Although he himself relied chiefly on morphology in his taxonomic work, he welcomed data from the other fields of botany as a possible source of information for distinguishing closely related entities. With well-balanced judgment and keen discernment he made his analytical studies and he derived much pleasure from searching out the identity of some miserable but challenging fragment. He believed that species, when once properly circumscribed, exhibited at least one character (not



FIG. 1. J. W. Stacey, summer, 1942.

necessarily a "key-character") by which they could be recognized at some period in their life history. When once he had this exclusive character clearly in mind, he knew his species and could recognize it no matter how variable it might be. Henceforth for him the species was "fixed" and rarely could he be persuaded to accept for it any subdivision into varieties.

Although his work with *Carex* was seriously conceived and executed, nevertheless the time he spent in study was really his period of recreation and relaxation away from business. It pleased him to make a sociable time of it, discussing the plant he had before him, expounding some theory of relationship or distribution, criticizing or praising some treatment in the work of Mackenzie for whom he had great admiration. In the herbarium or on field trips he talked of little else but *Carex*, a source of annoyance to non-botanical acquaintances who sometimes accused him of being narrow-minded. One of his chief sources of delight in conversation was to catch up unwary persons by exposing some scientific fallacy or rhetorical exaggeration in their speech. If a verbal tilt developed, he was never acrimonious nor argumentative, always allowing his adversary the satisfaction of justifying his statement; but from the twinkle in Mr. Stacey's eye one knew who had won, who had had fun. To fellow botanists he was generous of his means and knowledge but only so long as he felt he was being accorded an honest and true return in science and friendship.

As an amateur botanist interested in the general systematic botany of western vascular plants Mr. Stacey was one of the keenest and best-informed. Very few are the professional botanists who could have surpassed him in a knowledge of plants as they grow, a knowledge gained from methodical study while on recreational strolls and trips over a period of many years. In an attempt to organize the taxonomic data obtained on these outings, he prepared lists of plants for each of the counties bordering San Francisco Bay which are more complete than anything of which I know and which contain many entries indicative of his keen power of observation and his scholarly discernment.

The fullest scientific use of these lists cannot be realized unfortunately because only the exceptional entry is represented by a herbarium specimen for reference. Although a brilliant all-around field naturalist, Mr. Stacey was in no sense of the word a botanical collector. For him it was enough to search out the rarest plants where they grew, leaving to amateur collectors or professional botanists the task of preserving scientific herbarium records. A few specimens of his collecting will be found in the herbarium of the California Academy of Sciences but they are frequently represented by mere scraps or fragments sent to Miss Eastwood for determination or verification. After he seriously undertook the study of western carices, he made a real effort to

try to collect; but his almost-untouched stock of printed labels shows that his own activity as a collector fell far short of his intentions. How well I remember the collecting trips that he and I made to such rich localities as the *Ledum* swamp on the road to Point Reyes or to the Pitkin marsh in Sonoma County: while Mr. Stacey would freely wander about intent on plants in general and *Carex* in particular, I would spend most of my time digging and picking, collecting and pressing, specimens! The superb research collection of West American *Carex* in the herbarium of the California Academy of Sciences, however, proves that one need not be a collector to build a collection.

The published results of Mr. Stacey's research in *Carex* appeared chiefly as a series of "Notes on *Carex*" in Leaflets of Western Botany, volumes 1 and 2, from November, 1934, to February, 1939. There were fifteen contributions in this series which include descriptions of seven new species besides extended distributional data and notes on the identity of various critical species. His only other botanical writings of which I know are "Notes on some plant introductions, mostly Californian" (Leafl. West. Bot. 1: 69-71. 1933), and his treatment of the genus *Carex* in Kearney and Peebles Flowering Plants and Ferns of Arizona (U. S. Dept. Agric. Miscell. Publ. no. 423, pp. 168-175. 1942). A notice of Mr. Stacey's death appeared in Science (n. ser. 98: 464. 1943) and a brief obituary was published in Academy News Letter no. 48 (December, 1943).

When no longer able to give his serious attention to *Carex*, Mr. Stacey turned to another field of natural science and devoted his time and interest to ornithology. To this study he brought the same enthusiasm, the same critical discernment, which characterized his work in botany. Concerning his ornithological activity, the following was written in Academy News Letter no. 48: "In two or three years he had developed a field knowledge of birds that was surprising even to veteran observers. The new interest he had taken up at sixty-eight he pursued with the same intensity and thoroughness that had characterized all of his activities throughout his life; and after his death his executors found among his papers literally almost half a bushel of carefully written manuscript notes on birds."

John William Stacey was born in Galesburg, Michigan, on February 26, 1871, and died in San Francisco, California, October 16, 1943. His wife, the former Mrs. Florence Ward Waite whom he married in St. Louis shortly before coming to California, survives him. He attended the University of Michigan at Ann Arbor, taking courses in medicine and botany, and at least during one summer did botanical field work with C. F. Wheeler. After completing his medical course, he went to the Bellevue Hospital as an interne, but instead of completing his work and practicing, he specialized in the further study of drugs and took up editorial

work for medical publications. He came to San Francisco in 1914 where, shortly after, he became connected with the book department of The Emporium, first as head of the medical book department and later as head of the entire book department. In 1923 he founded the business firm of J. W. Stacey, Inc., which soon attained importance as an institution in medical and scientific circles throughout Western America. Evidence of the high esteem in which Mr. Stacey's store is held is observed in the fact that medical students are urged by their instructors to browse through his stock of books to acquaint themselves with the most recent literature of their field.

Although Mr. Stacey was always a scientist at heart, with particular interests in systematic botany and ornithology, these fields of scientific endeavor did not attract him professionally. His success in the business world was due in no small degree to his deep attachment to science, for it was the rare combination of his thoroughly scientific background, his naturally keen business ability, and his happy and animated personality that accounted for a career that was eminently successful and in some respects unique.

California Academy of Sciences,
San Francisco,
January, 1944.

DERMATITIS AND PHOTOSENSITIZATION PRODUCED BY *PTELEA ANGUSTIFOLIA*

W. C. MUENSCHER AND BABETTE I. BROWN

In the summer of 1942 and again in 1943 workmen in Highland Park, Rochester, New York, received a severe dermatitis believed to have been caused by contact with the leaves of *Ptelea angustifolia* Benth. (*P. lutescens* Greene), a member of the Rutaceae. Other plants in this family, *Dictamnus albus* L. and *Ruta graveolens* L. are known to cause a dermatitis in susceptible individuals but no records could be found of dermatitis caused by any species of *Ptelea*. This note is a report of some tests made by us which demonstrate that *Ptelea angustifolia*, a native shrub of the Southwestern United States, also may cause a severe dermatitis in some individuals.

The fresh material used in these tests was kindly supplied by Mr. R. H. Horsey, from introduced shrubs growing in Highland Park. We are indebted to Dr. Joseph N. Frost of Ithaca for his interest in the tests, for advice, and for the treatment of some of the more severe cases of dermatitis in two of the subjects.

Eight persons, all volunteers, were used as subjects in the

tests: subjects 1 and 3, adult white females; subjects 2, 4, 7 and 8, adult white males; subjects 5 and 6, adult oriental males.

EXPERIMENTS WITH *PTELEA ANGUSTIFOLIA*

The tests are recorded under time of exposure, subjects used, method of application and reactions or results obtained with each subject.

EXPOSURE 1. August 4, 9 A.M. Subjects 1 and 2.

Crushed leaves were rubbed, on an area 2 cm. in diameter, above the elbow of the left arm. Direct sunlight was excluded.

Subject 1. A slight reddening of the skin appeared over an area 3 by 4 cm. in diameter four days later. The color remained the same for four days and then began to fade. The spot was still visible on the tenth day when a slight itching was perceived.

Subject 2. No reaction.

EXPOSURE 2. August 4, 9 A.M. Subjects 1 and 2.

Crushed immature fruits were rubbed over an area 2 cm. in diameter below the left elbow. Direct sunlight was excluded.

No reaction occurred in either subject.

EXPOSURE 3. August 7, 1 P.M. Subjects 1, 2 and 3.

Crushed leaves were vigorously rubbed, on an area 3 cm. in diameter, far above the elbow on the left arm of subjects 1, 2 and 3, and also on the right upper arm of subject 1 and on the center of the upper back of subject 2. The areas were subsequently exposed to direct sunlight for one hour. A severe dermatitis developed in subjects 1 and 2 and a moderate dermatitis developed in subject 3. The development and history of the dermatitis on subjects 1 and 2 are recorded below; the hours or days indicate total time elapsed since the original exposure to contact with the leaves.

Subject 1. Right arm.

18 hrs. A small faintly red area was discernible.

30 hrs. A red area, 5 by 7 cm., was definitely outlined; it burned much as a sunburned skin.

40 hrs. The inflamed area, now 7 by 7 cm., was very sensitive and pained when touched.

48 hrs. Frank vesiculation appeared and edema began to develop.

52 hrs. Smaller blisters became confluent; one large blister had increased to 2 cm. in diameter.

54 hrs. Blisters were cut open, drained of yellow fluid and covered with dressing and kept moist with dilute boric acid for the following four days. After the fifth day the inflammation began to subside and considerable itching was experienced. The maxi-

num size of the blistered area, 6 by 8 cm., was reached on the sixth day. The blistered area developed new skin within a few days but it remained reddish-brown for two months.

The exposure on the left arm developed into a similarly severe dermatitis on an area 5 by 13 cm. within thirty hours. Its general course ran almost identical with that described for the right arm. The same treatment was applied.

Subject 2. Left arm.

- 18 hrs. A reddish spot 6 by 6 cm. was discernible.
- 30 hrs. Inflamed area red, 7 by 10 cm., with small whitish vesicle near the center.
- 40 hrs. Inflamed area 7 by 12 cm., with vesiculation especially near the center.
- 52 hrs. Frank vesiculation but some blisters becoming confluent, some 2 cm. in diameter and at least 1 cm. high, edematous; several had ruptured and were discharging a yellow fluid.
- 54 hrs. Blisters were cut open, drained and covered with dressings and kept moist with dilute boric acid solution for the following four days. After the fifth day the inflammation began to subside but considerable itching was experienced from then on for ten days. Even six weeks after exposure itching was severe whenever the subject perspired or became over-heated. The affected area was still reddish-brown after two months. The exposure on the back ran a course very similar to that on the arm except that the area was larger, 8 by 10 cm., with two radial streaks 2 by 6 cm. long extending toward the neck.

Subject 3. Left arm.

A reddish spot 6 by 8 cm. appeared within eighteen hours. It became more inflamed and small blisters developed within three days. The general appearance of the dermatitis was similar to that in subject 1 but much less severe. The affected area remained dark reddish brown for two months and then began to fade gradually but it was still visible fifteen weeks after the beginning.

EXPOSURE 4. August 9, 7 A.M. Subjects 1 and 2.

Crushed leaves were rubbed on an area 3 cm. in diameter on the inner side above the elbow of both arms (subject 1) and on the right arm (subject 2). Direct sunlight was excluded.

No reactions were observed in either subject.

EXPOSURE 5. August 14, 2 P.M. Subjects 1, 2 and 3.

Crushed leaves were rubbed lightly, on areas 1 cm. square, on the inner side of the right arm both above and below the elbow.

Direct sunlight was excluded.

No reactions were observed in any subject.

EXPOSURE 6. August 9, 2 P.M. Subjects 4, 5, 6, 7 and 8.

A small piece of crushed leaf was rubbed on an area approximately 2 cm. in diameter above and below the elbow of the left arm of each subject. The arm was not exposed to direct sunlight. Subject 4 developed a slight reddening of the skin of both areas of exposure four days later. Subjects 5, 6, 7 and 8 showed no reactions.

EXPERIMENT WITH *DICTAMNUS ALBUS*

August 7. Subjects 1, 2 and 3.

Crushed leaves were rubbed on an area 2 cm. in diameter on the right upper arm. The treated areas were exposed to diffuse sunlight for one hour.

No reaction developed in subjects 1 and 3. A severe dermatitis developed in subject 2. Within eighteen hours a red inflamed area, 5 cm. in diameter, had developed. It increased to 6 by 7 cm. and blisters developed. The general course of the development of the dermatitis and its response to the boric-acid solution treatment were very similar to that of *Ptelea angustifolia*.

EXPERIMENT WITH *RUTA GRAVEOLENS*

August 7. Subjects 1, 2 and 3.

Crushed leaves were rubbed on areas 2 cm. in diameter on the outside of the lower right arm of subjects 1 and 3, and on the extreme upper right arm of subject 2. The treated areas were exposed to direct sunlight for one hour.

A slight reaction was obtained in subjects 1 and 3. After thirty hours a definite reddening and inflammation of the skin was discernible over an area 5 by 7 cm. in subject 1 and on an area 7 by 12 cm. in subject 3. This was followed by more severe inflammation and itching but no vesiculation.

Subject 2 developed a severe dermatitis. Within eighteen hours after contact a red inflamed area 8 cm. in diameter was evident. After thirty hours the spot had increased to 10 by 11 cm. with frank vesiculation. The blisters soon became confluent and from then on the general appearance of the dermatitis and its response to treatment with boric-acid solution were identical to that caused by *Ptelea angustifolia*.

Of the eight subjects tested, three were highly susceptible to contact with the leaves of *Ptelea angustifolia*, one was slightly susceptible and four showed no reaction under the conditions of the tests. Subjects 1 and 2 developed only a slight reaction if not exposed to direct sunlight after contact with the leaves but developed a severe dermatitis if exposed to direct sunlight for one hour after contact. Of the five subjects who were tested without

subjecting them to direct sunlight after contact, only one showed a slight reaction.

The three subjects who were highly susceptible to *Ptelea angustifolia* were also tested for susceptibility to *Dictamnus albus* (gas plant) and *Ruta graveolens* (rue). Subject 2 was highly susceptible to all three species. Subjects 1 and 3 showed no reaction to *Dictamnus albus* and a slight reaction to *Ruta graveolens*.

SUMMARY

Contact with the leaves of *Ptelea angustifolia* causes a dermatitis in susceptible individuals. Exposure to direct sunlight subsequent to contact increases the severity of the dermatitis. This suggests that *Ptelea angustifolia* has a photosensitizing action. The dermatitis caused by *Ptelea angustifolia* is very similar to that produced by *Dictamnus albus* and *Ruta graveolens*. In the experimentally produced dermatitis the first inflammation appeared eighteen to thirty hours after contact with the leaves. The severe cases continued for about ten days.

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December, 1943.

ON THE SHOOT APEX OF CHLOROGALUM POMERIDIANUM (DC.) KUNTH¹

CLARENCE STERLING

Recent investigations on the structure of apical meristems have rekindled interest in the cyto-histology of the shoot apex as contrasted to the more static formulation of cell-wall patterns. (See reviews by Foster, 5; 6.) One of the main services of these studies has been to show the essential lability inherent in plant tissues and the consequent inadmissibility of posing strict categories and formulae within which plant life is to function.

Probably one of the most rigid "laws" imposed on the angiosperm shoot apex is that it have at least one stratum of cells which experiences anticlinal divisions exclusively, this cell layer being called variously a "dermatogen" or "tunica." Very few exceptions to this basic rule have been noted. Magnus (7) indicated divisions in the dermatogen of the tip of the lateral pistillate inflorescence of *Secale cereale*; Pottier figured such a pericline at the tip of a branchlet of *Ruppia maritima* (8, fig. 77) and in the apical meristem of the shoot of *Cymodocea nodosa* (8, fig. 197); and more recently Sharman (11, 12) found periclinal divisions at the summits of the

¹ The writer wishes to acknowledge the helpful advice and criticism of Dr. A. S. Foster in the preparation of the manuscript.

shoot apices of *Zea mays* and *Agropyron repens*, respectively. The apices of *Phoenix*, as figured by Ball (2), also indicate irregularities in the uniseriate tunica, possibly involving sporadic periclinal divisions. Aside from phylogenetic implications for the monocots, these observations have a significance in challenging fixed concepts on the structure of the angiosperm shoot apex.

The present discovery resulted during experimentation on shoot apices with various fixatives. One of these experiments

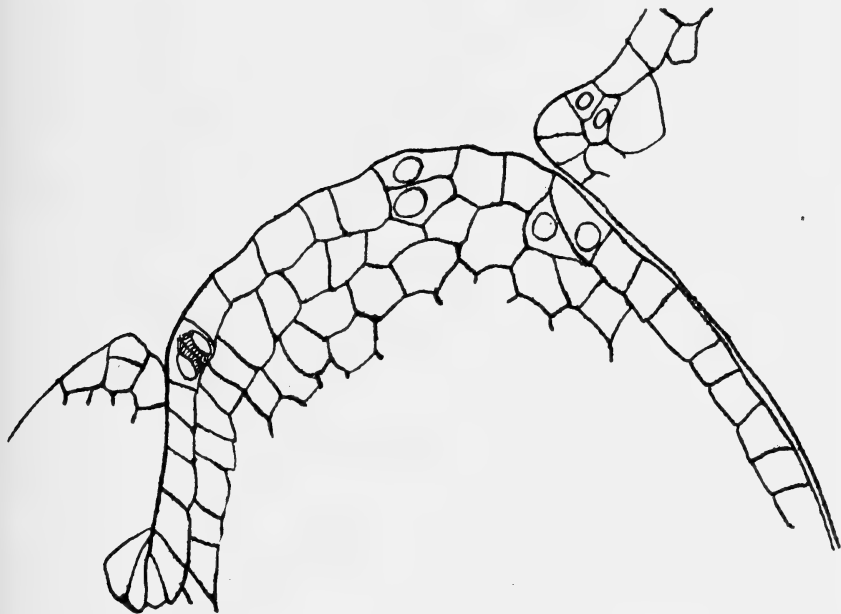


FIG. 1. Longitudinal section in near-median view of shoot apex of *Chlorogalum pomeridianum* ($\times 485$).

involved specimens of *Chlorogalum pomeridianum*, collected in April, 1941, near Fairfax in Marin County, California. Slides were made of the shoot apices of two bulbs. The sections were serial longitudinal, cut eight micra thick. Because of poor fixation of the apices, drawings were made by the camera lucida technique.

One of the apices, perhaps cut somewhat obliquely, shows only slight indications of previous periclinal divisions in the surface layer of cells. In the second apex, there is very definitely no discrete surface layer. Periclinal divisions have occurred at various places in this layer, both at the summit and on the flanks, with high frequency. Text figure 1, which is definitely median or near-median, shows several distinctive features of this apex:

derivatives of two periclinal divisions are observable at the summit of the shoot apex. An anticlinal mitosis on the left flank indicates that cell division is active. Both leaf primordia show periclinal divisions at their tips.

In text figure 2, the periclinal lines in the surface layer of the leaf primordia apices stand out particularly well. This section is only eight micra removed from that of text figure 1, being the adjacent cut. In this diagram, part of the wall of one of the periclinal

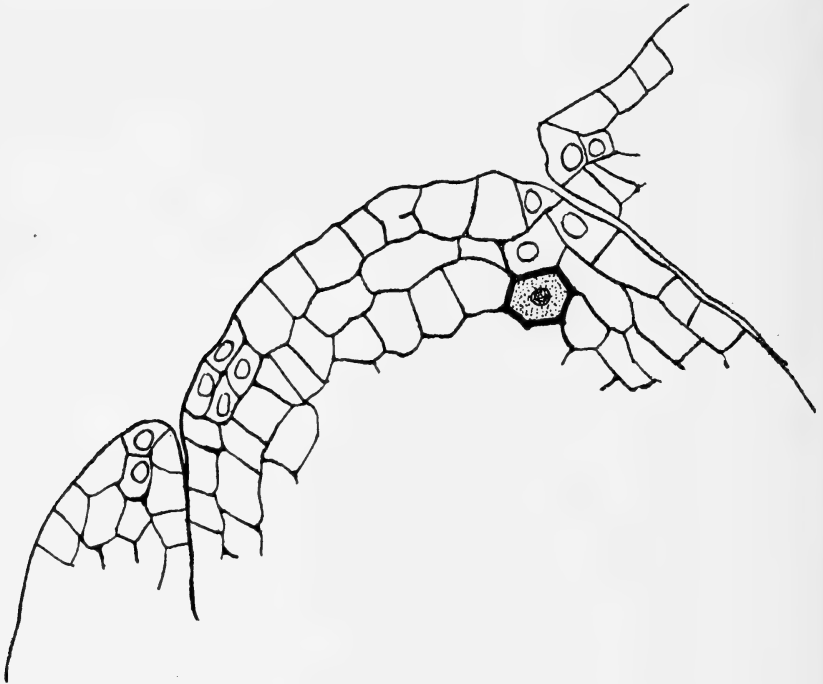


FIG. 2. Longitudinal section of shoot apex of *Chlorogalum pomeridianum*, 8 micra removed from section in fig. 1 ($\times 485$).

divisions of the previous section and a different aspect of the second pericline are recognizable at the shoot apex. Periclinal lines are visible on the left flank of the apical cone. The four cells here seem to be the derivatives of a single superficial cell, possibly as a result of a periclinal division immediately succeeded by anticlines in the daughter cells. The heavily-walled, deeply stained cell at the upper right of the figure is seemingly merely coincidental in occurrence in the apex.

DISCUSSION

Agnes Arber (1) has noted, in her discussion of the morphological nature of leaf and shoot, the general equivalence of

"tunica" and "corpus" in the initial regions of stem and leaf in angiosperms as well as the similarity, and even concurrence, in the manner of apical growth of these two organs in most of the general divisions of plants. This thesis is also a point of departure for Catalano's (4) support of Delpino's phytotic concept. These generalizations, however, are merely philosophical derivations from a group of basic anatomical data.

However, at present considerable data have been accumulated on the behavior of leaf and shoot apices in the monocots. The occurrence of periclinal divisions in the surface layer of the leaf apex of these plants is a well-established fact. As Sharman (11) points out, "In the Dicotyledons it may be involved in the production of the leaf edge, while in the Monocotyledons it is frequently concerned in the initiation of the leaves and often contributes considerably to their inner tissues." Sharman has cited most of the investigators who have observed periclinal divisions in the dermatogen of the monocot and dicot leaves. To his list can be added the works of Renner (9), Buder (3), Pottier (8), and Schalscha-Ehrenfeld (10).

It appears likely, therefore, that the shoot apices in monocots might possibly have some tendency toward occasional periclinal divisions in the surface layer. A further study of *Chlorogalum* and related plants would help to cast more light on the present rigid concept of "tunica" behavior in angiosperms.

Department of Botany,
University of California, Berkeley,
December, 1943.

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NOTES AND NEWS

OENOTHERA BRACHYCARPA GRAY IN TEXAS. Several collections of this rare and seldom observed *Oenothera* in the subgenus *Megapterium* have been made recently in north central Texas. Citations for these are as follows: breaks along north side of Brazos River, 6.5 miles south of Benjamin, Knox County, May 15, 1941, *Cory* 37205 (in flower); Camp Barkeley, Taylor County, April 11, 1943, *Tolstead* 6960 (in bud), in red clay soil at west side of camp, July 1, 1943, *Tolstead* 7537 (in fruit).

In the description of the subgenus *Megapterium* (North American species of the subgenera *Lavauxia* and *Megapterium* of the genus *Oenothera*. *Amer. Jour. Bot.* 17: 363. 1930), Dr. Philip A. Munz states, "Seeds as in *Lavauxia*, but in one row in each cell of the capsule, and with corky tubercles." Examination of the capsules of the above cited fruiting specimen of *Oe. brachycarpa* shows the seeds to be arranged in two rows in the capsules as in the subgenus *Lavauxia*. This is also true for *Oe. Wrightii* (regarded as a variety of *Oe. brachycarpa* by some). *Oenothera missouriensis* and its relatives, also members of the subgenus *Megapterium*, do, however, have their seeds arranged in one row in the capsule. V. L. CORY, Texas Agricultural Experiment Station.

The following two items were received too late for review in this issue of MADROÑO but mention is here made to call them to the attention of our readers. Under the title "The Citrus Industry" by H. J. Webber and L. D. Batchelor (University of California Press) an amazing lot of strictly botanical information is hidden. For instance, Chapter IV by Walter T. Swingle, contains 345 pages entitled "The Botany of Citrus" and comprises a taxonomic monograph of the Aurantioideae of the Rutaceae. Chapter VI deals with the general morphology, histology and physiology of the group and is under the authorship of E. T. Bartholomew and H. S. Reed. The second item is "The Flowering Plants and Ferns of Mount Diablo, California" by Mary L. Bowerman, published by the Gillick Press, Berkeley, California.

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STRUCTURE AND TAXONOMY OF TAENIOMA, INCLUDING A DISCUSSION ON THE PHYLOGENY OF THE CERAMIALES

GEORGE F. PAPENFUSS

The genus *Taenioma* was founded by J. Agardh (2) in 1863 to receive a species which he (1) had previously described as *Poly-siphonia perpusilla*. He placed *Taenioma* in the Rhodomelaceae while Schmitz (41) in 1889 included it in his newly created Sarcomeniaceae, a sub-family of the Delesseriaceae. In conjunction with his monograph on the Rhodomelaceae, Falkenberg (14) also studied *Taenioma* with the specific purpose of demonstrating, by way of contrast, the differences in construction of the thallus between the Rhodomelaceae and Delesseriaceae. The majority of later writers (De Toni, 12, 13; Børghesen, 5, 6; Kylin, 28; and others) who have been concerned with this genus have followed Schmitz and Falkenberg in assigning it to the Delesseriaceae.

Subsequent to the work of Falkenberg, the most important paper on *Taenioma* has been that of Thompson (43) in 1910. Thompson discovered cystocarps for the first time in the genus and from a somewhat superficial study of them concluded that *Taenioma* belonged in the Rhodomelaceae. Recently this view was also adopted by Hollenberg (19). Thompson and Hollenberg, however, overlooked the most significant structural feature distinguishing the Delesseriaceae from the Rhodomelaceae, namely, the difference in the order of formation of the pericentral cells. As was shown by Falkenberg, the pericentral cells in *Taenioma* are formed in the manner characteristic of the Delesseriaceae. This question will be taken up more fully in later pages, after the structure of the thallus has been reviewed.

Kylin (24) in 1923 pointed out that the Sarcomeniaceae should be united with the Delesseriaceae, a conclusion borne out by the work of Papenfuss (35) on *Claudea* and *Vanvoorstia*. Knowledge concerning the structure and reproduction of the majority of other genera in this old sub-family is meager. Through the work of Falkenberg (14), Thompson (43), Thuret (9), Børghesen (5) and Okamura (33), *Taenioma* has become one of the better-known members of the Sarcomeniaceae. Although sexual organs were not present in the writer's material, certain observations on the structure of the thallus and the development of the tetrasporangia seem worthy of record.

The anatomical work in the present study was made on Hawaiian and South African plants of *Taenioma perpusillum*. The South African material was kindly supplied by Dr. Mary A. Pocock who collected it at Arniston (May 7, 1940) and Port Elizabeth (Dec. 8, 1942, with tetrasporangia). The species has been

reported as occurring in South Africa. The record is based on Kützing's (23) *Polysiphonia nana*; but, as will be pointed out farther on, it is very doubtful if *P. nana* is representative of *Taenioma*. The Hawaiian material was collected by the writer during the years 1940-42 at the following localities on the island of Oahu: Hanauma Bay (March 30, 1941); 1.8 miles northwest of Nanakuli (May 16, 1942, with tetrasporangia); Waikiki (Nov. 17, 1940, and Aug. 21, 1941). Additional Hawaiian material was kindly furnished by Mrs. D. Abbott who obtained it on the ascidian *Pyura momas*, collected by members of the Department of Zoology of the University of Hawaii, at Kaneohe Bay, Oahu (Feb. 11, 1941, with tetrasporangia). All the material collected by the writer was obtained in the intertidal zone, where the species occurs as an epiphyte on *Bornetella* and a variety of small turf-forming algae. *T. perpusillum* had been reported from Hawaii in 1880 by Chamberlain (10) but the record has escaped notice.

The Hawaiian and South African plants seem to be identical in every respect. South African specimens received from Dr. Pocock in 1939, while the writer was working at Lund, were compared with the type material of *T. perpusillum* (nos. 43342 and 43343 in Herb. Agardh) and found to correspond very well. Since only dried South African plants were available for the present study, the following account is based entirely upon observations on Hawaiian material, which was preserved in formalin.

STRUCTURE OF THALLUS

Taenioma is a small alga, measuring less than three millimeters in height, and consisting of a prostrate, terete, branched, indeterminate main axis, attached by non-septate rhizoids on the ventral side and forming erect, terete, secondary indeterminate axes on the dorsal side. According to Falkenberg (14), the erect branches are determinate, but from the writer's observations there seems to be no evidence for this. Both prostrate and erect axes are monopodial and grow by means of a single transversely-dividing initial. The axes are composed of segments consisting of a central and four pericentral cells. The rhizoids arise as outgrowths from the ventral pericentral cells of the prostrate parts. The ascending axes are formed alternately at an interspace of three to eight segments, and by bending upward give the impres-

EXPLANATION OF THE FIGURES. PLATE 23.

PLATE 23. *Taenioma perpusillum*. FIG. 1. Portion of thallus showing an erect axis with alternate determinate branches and with indeterminate branches on the adaxial side of the latter, $\times 125$. FIG. 2. Portion of a determinate branch with three young apical hairs, $\times 600$. FIG. 3. Distal ends of determinate branches showing the terminal monosiphonous hairs, $\times 125$. FIG. 4. Basal region of a determinate branch with mature tetrasporangia, $\times 600$.

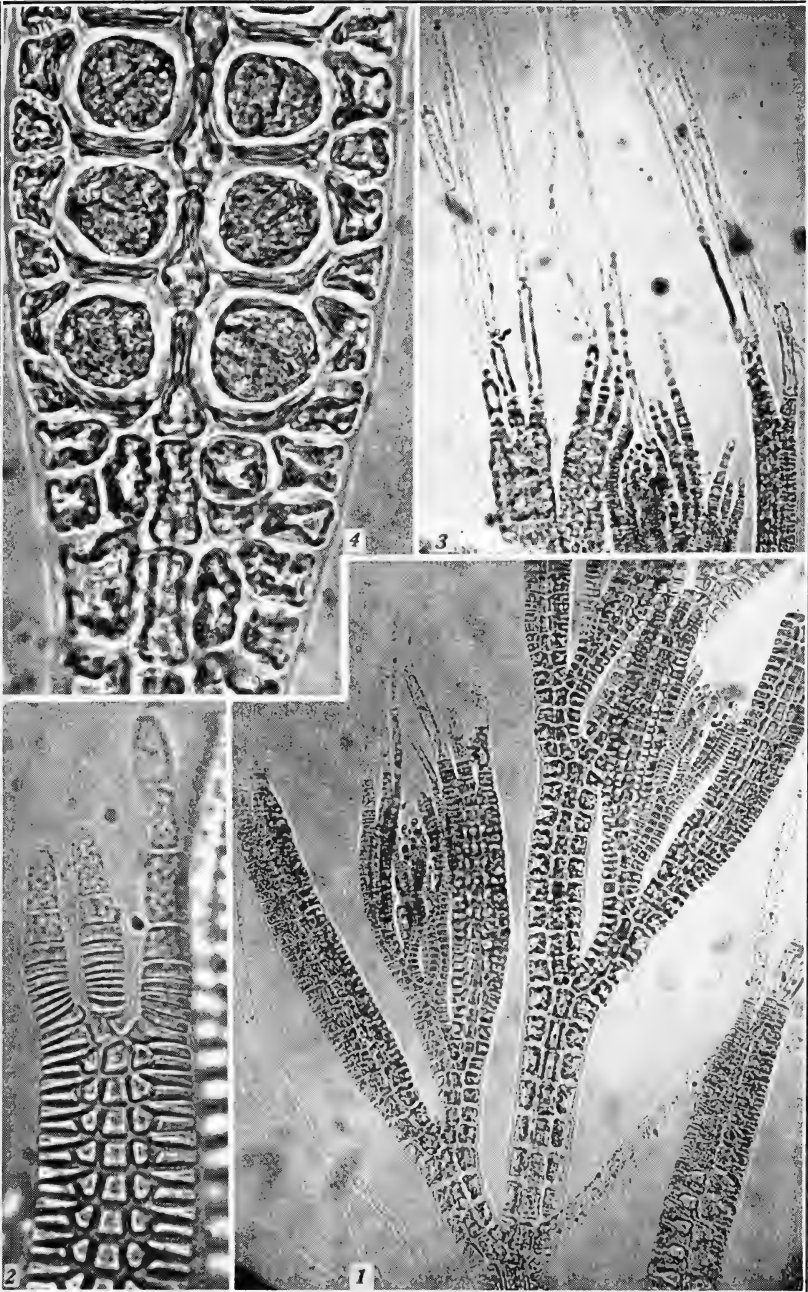


PLATE 23. TAENIOMA PERPUSILLUM. Photomicrographs by T. T. McCabe.

sion of having arisen in a second series from the dorsal side of the prostrate axis.

Starting at the third, fourth or fifth segment from the base, the erect secondary axes give rise to determinate branches alternately at an interspace of two to nine segments (fig. 1). These branches, in contrast to the indeterminate axes, are five cells in width, except at the base, and are therefore flat (figs. 1, 2, 11, 12, 14). At an early stage in development, three hairs are formed at the tip of each determinate branch (figs. 1-3, 11-14) whereupon all further growth in length by segment formation ceases in such a branch.

When a developing determinate branch is two or three segments long, it frequently initiates on its adaxial side an indeterminate branch which in a manner similar to the secondary axes forms determinate branches of a higher order (figs. 1, 7; see also Thompson, 43, fig. 3). This process whereby a determinate or an indeterminate branch of one order gives rise to a higher order of branch of the opposite type is repeated over and over.

METHOD OF BRANCHING. When a branch is to be initiated, the apical cell, which ordinarily divides transversely, forming disk-shaped segments, divides by an oblique wall, leaving a segment which on one side is higher than the other (figs. 5, 7). Through enlargement the higher side of this segment forms a protuberance which is cut off. The cell so formed is the initial of a branch (fig. 6). This method of branching has been termed exogenous branching by Falkenberg (14). The original initial retains its rôle as the apical cell of the axis. Both apical cells next divide in the usual transverse fashion, giving rise to two monosiphonous filaments whose segments eventually undergo division. In the case of the erect axes, the branches formed are always alternate and of the determinate type while the prostrate main axis forms alternate and commonly erect, indeterminate branches. As stated above, a determinate branch usually forms an indeterminate branch on its adaxial side (figs. 1, 7). These branches are also exogenous in origin.

Although indicated in Falkenberg's (14) figure 23 on plate 15, and described and figured by Thompson (43, p. 100, fig. 4), the exogenous manner of branching in *Taenioma* has not received recognition commensurate to its importance. This method of branching is of common occurrence in the Rhodomelaceae, Dasyaceae, and Ceramiaceae but is rarely met with in the Delesseriaceae. In other members of this family, the branches are formed in one or more of the following ways: (1) marginal as in *Membranoptera alata* (Kylin, 24, p. 110, fig. 70), (2) from a cortical cell on the midrib as in *Apoglossum ruscifolium* (Kylin, 24, pp. 85-86, fig. 55b), (3) endogenously as in *Claudea* and *Vanvoorstia* (Papenfuss, 35), or (4) entirely adventitiously from cortical cells

as in *Membranoptera alata* (Phillips, 37) and *Claudea multifida* (Papenfuss, 35).

The only other member of the Delesseriaceae which is known to show exogenous branching is *Caloglossa*. Nägeli (32) as long ago as 1855 showed that in *C. Leprieurii* the branches are initiated by segments which are formed as the result of an oblique division of the apical cell of the parent branch (Nägeli, *op. cit.*, p. 71, pl. 8, figs. 9-10). He also pointed out that the axis is monopodial and that the branches are alternate in position. In manner of growth and branching *Caloglossa* thus agrees with *Taenioma*. It should be mentioned, however, that in *Caloglossa* branches also occur on the midrib, but the exact method of their initiation is unknown. In general, Nägeli's work has not been correctly interpreted, since it is usually stated that in *Caloglossa* the lateral branches are marginal in origin.

STRUCTURE OF DETERMINATE BRANCHES. The determinate branches are formed alternately at an interspace of two to nine segments on the terete, erect, indeterminate branches (fig. 1). The apical cell of the young branch by transverse division forms segments in the manner characteristic of the Delesseriaceae. When a determinate branch is but two or three segments long, its apical cell frequently divides by an oblique wall, cutting off a segment which gives rise to an indeterminate branch on the adaxial side (fig. 7). Following the initiation of this branch, the apical cell by transverse divisions forms from 12 to 20 segments. There are then formed by alternate oblique divisions two segments (fig. 8) which are similar to those which initiate branches. Each of these two segments gives rise to an apical cell (figs. 9, 10). At this stage, the branch apex is thus crowned with three initials. The latter by transverse division give rise to the three monosiphonous hairs which adorn the tip of the mature determinate branch (figs. 10-14, 2-3).

As has been pointed out by Falkenberg (14) and Thompson (43), the hairs terminate all growth in length by cell formation and are responsible for the determinate character of these branches. According to Børgesen (5) and Okamura (33), intercalary divisions occur at the base of a hair, but the writer can find no evidence of this. The cells of the hairs are formed in acropetal succession by division of the apical cell. Those at the base merely fail to elongate as much as the distal ones and give the false impression of having been formed by intercalary divisions.

While the hairs are in course of formation, the part of the determinate branch posterior to them continues its development. This is best described in connection with figures eight and eleven to thirteen.

At the time that the hairs are initiated, the segments immediately below the two hair-forming ones are still undivided (fig. 8).

The division of the segments to form pericentral cells is shown in figure eleven. It will be seen from this figure that the second and third segments below the large triangular cell, representing the segment which initiated the first hair, have each formed a lateral pericentral cell, while in the following three segments both lateral pericentral cells have been formed. In the seventh and subsequent segments down from the triangular cell, both the transverse pericentral cells have been cut off, but only one in each segment is indicated in the figure. At this stage the segments thus consist of a central and four pericentral cells.

Mature determinate branches, in contrast to indeterminate ones, are flat, except for the segments below and the three to five immediately above the place of insertion of the daughter indeterminate branch, which remain cylindrical. This flat form is produced as the result of the formation of two flanking cells by each of the lateral pericentral cells.

The transverse pericentral cells do not divide and the branch consequently remains only three cells in thickness at the midrib. The method of formation of the flanking cells is shown in the lower three segments in figure twelve. It will be seen that the pericentral cells first divide by an oblique wall, more or less transverse to the branch axis, to form a flanking cell toward the branch apex. The next division is also in a vertical plane and cuts off the second flanking cell from the portion of the pericentral cell below the first-formed flanking cell. After the four flanking cells have been cut off, no further divisions occur in the segments of a determinate branch.

EXPLANATION OF THE FIGURES. PLATE 24.

PLATE 24. *TAENIOMA*. FIGS. 5-16, *Taenioma perpusillum*. FIG. 5. Oblique division of the apical cell of an indeterminate branch to form a branch-initiating segment. FIG. 6. Division of a branch-initiating segment to form an apical cell, the cell to the right. FIG. 7. An indeterminate axis with two alternate young determinate branches, each of which has initiated an adaxial indeterminate branch, while the apical cell of the axis has divided by an oblique wall in preparation for the formation of a determinate branch to the right (the oldest of the determinate branches, the one to the right, is in an early stage of hair-formation, as seen in a side view of its apex). FIGS. 8-10. Early stages in the formation of the three terminal hairs, the central initial representing the original apical cell of the branch. FIGS. 11-13. Young determinate branches showing the further development of the hairs and the division of the segments of a branch initial to form a central cell, four pericentral cells, and the two cells which flank each of the lateral pericentral cells. FIG. 14. Optical longitudinal section parallel to the surface of a determinate branch showing early stages in the formation of tetrasporangia (cover cells were present in the two lower segments but are not indicated in the figure). FIG. 15. Optical vertical section through a row of fertile lateral pericentral cells of a tetrasporangia-bearing branch showing the formation of two cover cells by the stalk cell in the two older segments. FIG. 16. Optical longitudinal section parallel to the surface of a determinate branch with mature tetrasporangia. FIG. 17. *Taenioma macrourum*, terminal portion of a young determinate branch with its two apical hairs in the course of development (material from the Bahamas, *Howe 5708*). (Figs. 5-15, 17, $\times 780$. Fig. 16, $\times 340$.)

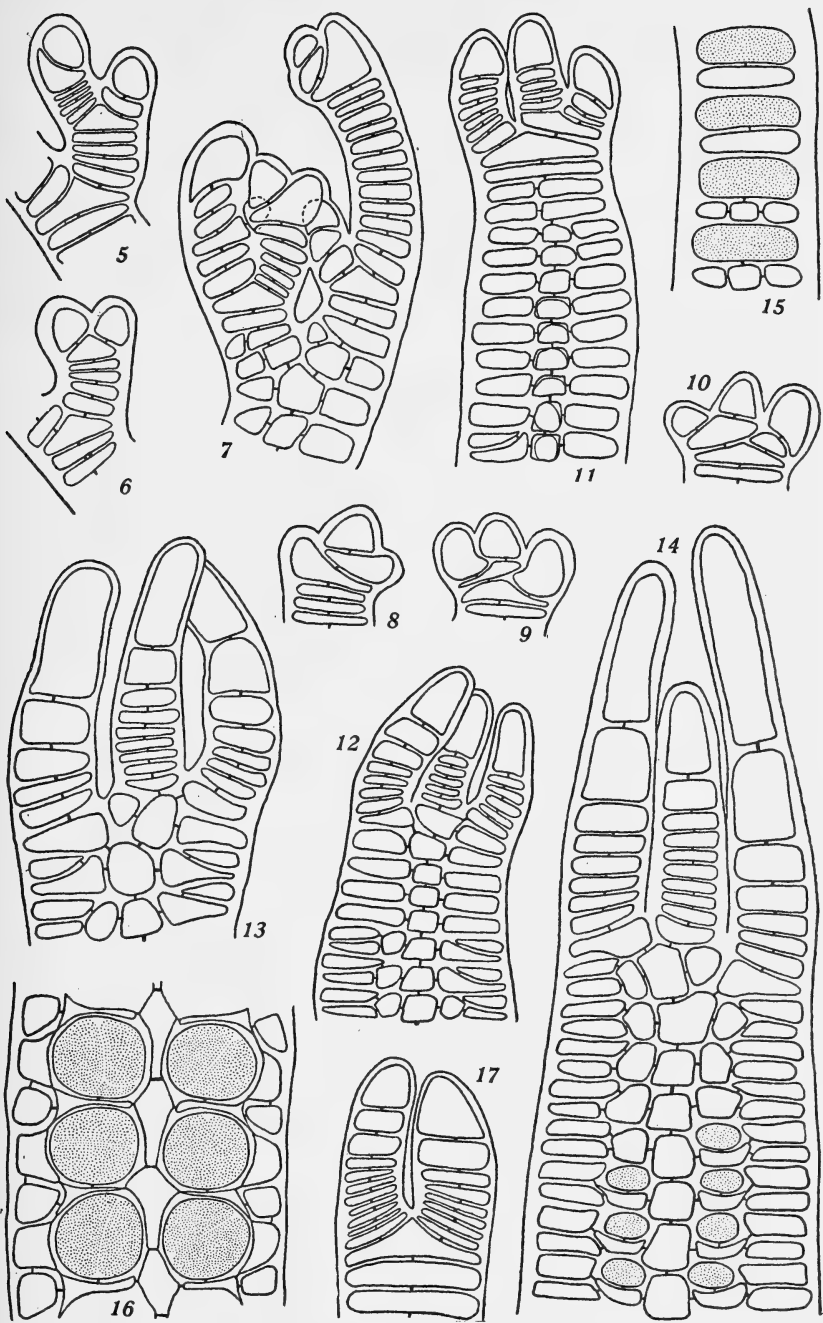


PLATE 24. TAENIOMA.

The division of the two hair-forming segments is similar to that of other segments (figs. 12–14), except that in the distal one, the lateral pericentral cell on the side opposite to the point of attachment of the hair fails to form flanking cells (figs. 2, 14).

No intercalary cell divisions occur anywhere in the thallus of *Taenioma*. Secondary pit connections are formed between neighboring cells, except in the case of the central cells, which do not become secondarily connected to each other nor to other cells.

Although the thallus of *Taenioma* is extremely simple, the construction of the determinate branches is nevertheless in accordance with the plan basic to all Delesseriaceae (cf. Kylin, 24, pp. 67–69, 81–82). Three categories of cells may thus be recognized: (1) a cell-row of the first order, represented by the central cells; (2) a cell-row of the second order, represented by the lateral pericentral cells and the upper of the two flanking cells; and (3) a cell-row of the third order, represented in the determinate branches of *Taenioma* by a single cell, the lower of the two flanking cells (figs. 2, 12–14).

It was stated earlier that *Taenioma* is to be included in the Delesseriaceae rather than in the Rhodomelaceae on the basis of the sequence in which the pericentral cells are formed.

That there is a fundamental difference in the order of formation of the pericentral cells in the Rhodomelaceae and Delesseriaceae was first pointed out by Nägeli (31) in 1847. From his studies of *Hypoglossum Woodwardii*, species of *Polysiphonia* and other representatives of both Delesseriaceae and Rhodomelaceae, Nägeli (29, 30, 31) established that in the Delesseriaceae the two lateral pericentral cells are formed before the two transverse ones (Nägeli, 29, pl. 1, fig. 9). In the Rhodomelaceae, on the other hand, the pericentral cells are formed in a progressive alternate sequence, with reference to the first one, until the circle is completed. The last-formed pericentral cell thus occupies a position diametrically opposite the first-formed (Nägeli, 30, pl. 7, figs. 33–37).

Since the time of Nägeli, hundreds of species of both Delesseriaceae and Rhodomelaceae have been studied by a large number of workers but not a single exception to these plans has been found. In the manner typical of the Delesseriaceae, the two lateral pericentral cells are also the first to be found in *Taenioma* (fig. 11; see also Falkenberg, 14, p. 710, pl. 15, figs. 25–26; and Thompson, 43, p. 101).

In the Delesseriaceae, with the exception of *Taenioma* and *Caloglossa*, lateral organs are not initiated by a segment prior to the formation of its pericentral cells. In the majority of Rhodomelaceae, to the contrary, the lateral organs are initiated before the segment cells have formed pericentral cells. Subsequent to Nägeli, many workers have consequently been concerned with problems relating to the position of the pericentral cells

with reference to the lateral organs and to one another. The following are some of the more important questions which have been studied: (1) the position of the first pericentral cell, (2) whether the second pericentral cell is formed to the left or to the right of the first, (3) whether or not the position of the second pericentral cell is constant in a given species, and (4) whether or not the second pericentral cell follows the spiral described by the lateral organs. For a summary of knowledge concerning these interesting questions, the reader is referred to the excellent paper by Rosenberg (38, pp. 5-9, 31-32).

In this connection, it may be mentioned that in the Dasyaceae, according to Rosenberg (38), the pericentral cells are formed in a progressive left-hand sequence, with reference to the first one, as seen from the outside, so that in the completed circle the youngest lies to the right and next to the first-formed. The Dasyaceae, Delesseriaceae and Rhodomelaceae thus differ very sharply from one another in regard to the plan in which the pericentral cells are formed. In the remaining family of the Ceramiales, the Ceramiaceae, typical pericentral cells are of course not formed.

In addition to the difference in plan of pericentral cell formation, the Delesseriaceae may also be distinguished from the Rhodomelaceae, as was pointed out by Falkenberg (14, p. 713), by the fact that in the Delesseriaceae the lateral pericentral cells always form two flanking cells, which in the majority of forms function as the mother-cells of initials which give rise to lateral rows of cells. Each of these flanking cells has a primary pit-connection with the pericentral cell and their combined length equals that of the pericentral cell.

In the few examples of Rhodomelaceae where a similar formation of flanking cells occurs, only one flanking cell is formed by each pericentral cell. This cell is cut off by a longitudinal division and is therefore as long as the pericentral cell. It may later divide transversely so that there are two (or more ?) flanking cells. Only one of these cells, however, will be united to the parent pericentral cell by a primary cytoplasmic connection.

In regard to the manner of flanking cell formation *Taenioma* thus also shows itself to be a member of the Delesseriaceae.

REPRODUCTION

TETRASPORANGIA. Several of the earlier workers have recorded tetrasporangia in *Taenioma*. The development of these organs has, however, been studied only by Thompson (43). The writer's observations are in agreement with those of this author.

The sporangia are cut off in acropetal succession from the lateral pericentral cells in the expanded distal portion of the determinate branches (fig. 14). Each pericentral cell forms only one sporangium. It is separated by a concave wall from the

terminal end of the pericentral cell and is in cytoplasmic communication with this cell only (fig. 14).

After a sporangium has been initiated, the remaining portion of the pericentral cell, at this stage referred to as the stalk cell, divides by two walls parallel to the surfaces, forming a small cover cell on each (fig. 15). In *Taenioma* the cells so formed never enlarge or divide to form a protective layer over the sporangium, but remain as rudimentary cover cells on either surface of the stalk cell. The sporangia thus remain exposed on two sides during their entire existence (figs. 4, 16). In the mature sporangia-bearing branch, the central cells of the branch and the stalk cells of the sporangia are considerably stretched by the enlarging sporangia, and the marginal cells become connected by secondary pit-connections to neighboring marginal and stalk cells (fig. 16).

The method of sporangium-formation in *Taenioma* is comparable to that in *Vanvoorstia* (Papenfuss, 35, figs. 67, 68). In both genera the sporangia are formed by pericentral cells which have not yet become corticated, and the cover cells are formed after the sporangia have been initiated. The subsequent development in the two genera is different, however, in that the primary cover cells grow and divide in *Vanvoorstia*, forming a complete protective tissue over the sporangia, whereas in *Taenioma* the cover cells serve no protective purpose and the sporangia remain exposed.

By the method of sporangium-formation, *Taenioma* thus again shows itself to be a member of the Delesseriaceae. In the Rhodomelaceae, the pericentral cells destined to produce sporangia first form two cover cells by longitudinal divisions and then divide by a transverse wall to form the sporangium (cf. Kylin, 28, p. 173). The situation in the Rhodomelaceae is thus the reverse from that in *Taenioma* and *Vanvoorstia* where the sporangium is the first cell to be cut off by a fertile pericentral cell.

In those Delesseriaceae and Rhodomelaceae in which the sporangia are initiated by cells other than the pericentral cells this sequence is maintained (cf. Kylin, 28, pp. 170, 174-175). The significance of this distinction between the Delesseriaceae and Rhodomelaceae will appear later.

SPERMATANGIA AND CYSTOCARPS. Sexual organs have been but rarely observed in *Taenioma*. None were present in the writer's material. Spermatangia were recorded for the first time by Schmitz and Hauptfleisch (42, p. 415) in 1897, and for a second time by Thompson (43) in 1910. From the descriptions of these authors and from the figures of Thompson, it is clear that the spermatangia are formed directly on the branches (the determinate branches) as they are in all other Delesseriaceae. In the Rhodomelaceae the spermatangia are usually formed on trichoblasts, although, as pointed out by Falkenberg (14), there are exceptions to this rule. In a few genera such as *Bostrychia* and

Rhodomela, the spermatangia are formed on ordinary polysiphonous branches.

According to Thompson, the lateral pericentral cells become divided by vertical walls prior to the formation of spermatangial mother-cells. This statement requires verification. In other monostromatic Delesseriaceae the primary cells become divided by two walls parallel to the surface, forming a layer of cells on each surface. The superficial cells so formed then become divided by vertical walls to form the spermatangial mother cells. The spermatangia are formed on the surface of these cells. The mature spermatangial sorus is thus composed of five cells in thickness. Thompson describes and figures the mature sorus of *Taenioma* as consisting of four cells in thickness.

Cystocarps have been observed with certainty only by Thompson (43). The record by Collins and Hervey (11) of a mature cystocarp in material from Bermuda (Phyc. Bor.-Amer. no. 1935) is very doubtful, since duplicate material of this collection which was examined by Howe (20) proved to be a rhodomelaceous alga. The writer has found the same to be true of the duplicate material in the Herbarium of the University of California.

Nothing is known of the development of the procarp in *Taenioma* and very little concerning the cystocarp. According to Thompson, the cystocarps occur on the terete branches. This may seem unusual in view of the fact that the sporangia and spermatangia occur on the flattened determinate branches. From the position of the cystocarp Thompson concluded that this organ is a modified branch. This assumption is logical. It seems likely, however, that the cystocarps are initiated on young determinate branches but that such branches do not complete their normal growth and in the course of development of the cystocarp become incorporated in its wall. Comparable conditions obtain in *Claudea* and in *Vanvoorstia* (cf. Papenfuss, 35, pp. 26, 43, figs. 23, 42, 43, 51).

From the general shape of the cystocarp and the gross structure of the gonimoblast, Thompson concluded that *Taenioma* belonged in the Rhodomelaceae. Through the researches of Falkenberg and of Kylin and his students, we now know, however, that there are no sharply defined and constant differences between the Rhodomelaceae and Delesseriaceae with respect to the development and structure of the cystocarp.

TAXONOMY

In addition to *T. perpusillum*, which was described by J. Agardh (1, 2) from material collected by Liebmann at St. Augustin on the Pacific coast of Mexico, two other species, *T. macrourum* Thuret (9) and *T. Clevelandii* Farlow (15), have been credited to *Taenioma*.

Taenioma macrourum was established by Thuret in 1876 upon material collected by Schousbee at Tangier, Morocco. In considering his plant as distinct from *T. perpusillum*, Thuret seems to have been influenced more by the widely separated stations of the two species than by morphological differences. Without being aware of it, he did, however, describe and figure a feature whereby *T. macrourum* can readily be distinguished from *T. perpusillum* as characterized by J. Agardh. According to Thuret the tetrasporangia-bearing branches of *T. macrourum* terminate in two hairs while those of *T. perpusillum*, according to J. Agardh, end in three hairs. This character is of the first importance in separating these two species as will be shown farther on.

Bornet (8) in 1892 reduced *T. macrourum* to the synonymy of *T. perpusillum*, and this point of view has been accepted by the majority of workers, including De Toni (12), Howe (in Thompson, 43, p. 98, note), Børgesen (5, 6), Okamura (33) and others. Falkenberg (14) and Schiffner (39, 40), on the other hand, have retained *T. macrourum* as an independent species. Schiffner does not give his reasons for so doing but Falkenberg, upon comparing *T. perpusillum* from the Pacific with material of *T. macrourum* from the Mediterranean, concluded that the former species lacked the long monosiphonous terminal hairs characteristic of the latter. The branches in *T. perpusillum* were also separated by an interspace of more segments, causing the plants to be less compact than in *T. macrourum*.

Although it is not possible to uphold the characters relied upon by Falkenberg, the writer's study nevertheless favors separation of the two species. As mentioned earlier the plants at hand of *T. perpusillum* came from Hawaii and South Africa. The observations on *T. macrourum* are based upon material from the Bahamas (Howe 5708, as *T. perpusillum*—Herb. Univ. Calif. no. 207218) and from the Adriatic (Schiffner, Alg. mar. no. 860—Herb. Univ. Calif. no. 495029).

From the account of the structure of the determinate branches of *T. perpusillum* it is seen that the terminal hairs are formed in a very precise manner. In this species the apical cell of a developing determinate branch forms a number of disk-shaped segments by transverse divisions and then, by alternate oblique divisions, two segments which on one side are higher than the other. These two segments form initials which together with the original apical cell of the branch give rise to the three terminal hairs characteristic of this species. In *T. macrourum* only one terminal segment is formed by an oblique division of the apical cell of a determinate branch and as a result the tips of these branches are crowned with only two hairs (fig. 17; also see Thuret, 9, pl. 25, fig. 1; Falkenberg, 14, pl. 15, figs. 21, 22; Børgesen, 5, fig. 337).

Since none of the plants studied by the writer showed part of the branches ending in three hairs and the rest in two, there

is reason to believe that the number of hairs is constant in a species: in *T. perpusillum* the determinate branches invariably end in three hairs while in *T. macrourum* they end in two.

Another feature which may be of importance in separating *T. perpusillum* from *T. macrourum* is that in the former the determinate branches usually form an adaxial indeterminate branch near their base, while in the latter such branches are rare. Consequently in *T. perpusillum* the thallus is more profusely branched than in *T. macrourum*. Before it could be conclusively stated, however, that this latter character is of systematic value, it would be necessary to examine more material of *T. macrourum* than has been available to the writer.

Bornet (8) when uniting *T. perpusillum* and *T. macrourum* listed as a synonym the South African species described by Kützing (23) in 1863 as *Polysiphonia nana*, while Falkenberg (14) gave the latter as a synonym of *T. macrourum*. Kützing figured *P. nana* as having some branches ending in a large inflated, apical cell and others ending in two hairs. If *P. nana* were a species of *Taenioma*, it would thus be logical to consider it as representative of *T. macrourum*; and since *nana* is the older specific name it would have priority over *macrourum*. The writer has not had the opportunity of examining Kützing's material nor has he been able to identify with certainty a South African plant with Kützing's species. Judging from Kützing's description and figure, however, there is little reason for believing that *Polysiphonia nana* is representative of the genus *Taenioma*. It seems more likely that the species is a rhodomelaceous alga. The segments show four parallel, vertically elongated, cells of the same length, which suggest pericentral cells as seen in surface view.

The third species of *Taenioma*, *T. Clevelandii*, was described by Farlow (15) in 1877 from material collected by Cleveland at San Diego, California. In a recent paper Hollenberg (19) records having again found the species; and he also refers to specimens in the Herbarium of the University of California. According to Hollenberg *T. Clevelandii* was reduced to the synonymy of *T. perpusillum* by De Toni (13). The cited work of De Toni, however, contains no statement to this effect.

From a study of the material in the Herbarium of the University of California and from the account of Hollenberg, it is clear that *T. Clevelandii* is not a species of *Taenioma* but belongs to the genus *Platysiphonia* Børgesen (7). Weber-van Bosse (45) already in 1896 remarked upon the great similarity in structure between *T. Clevelandii* and *Sarcomenia miniata*, which is now *Platysiphonia miniata*. *T. Clevelandii* differs from the other two species of *Taenioma* in the following important features which it shares with *Platysiphonia*: (1) The branches are endogenous in origin. (2) No terete branches are formed, that is, the lateral pericentral cells in all branches divide to form two flanking cells. (3) It does not

have determinate branches which end in hairs. (4) In the tetrasporangia-bearing branches, the sporangia on one surface are covered by a large cell and on the other by a rudimentary cover cell. These branches thus have a dorsiventral organization. In *Taenioma* both cover cells are rudimentary.

In habit *T. Clevelandii* resembles *Platysiphonia intermedia*. The relation of these species to each other can, however, only be established from a detailed comparative study based on preserved material. Pending such a study, it seems best to retain them as distinct entities.

The nomenclature and the geographical distribution of the species of *Taenioma* may be summarized as follows:

TAENIOMA PERPUSILLUM (J. Ag.) J. Agardh, Sp. Alg. 2(3): 1257. 1863. *Polysiphonia perpusilla* J. Agardh, Öfvers. Kgl. Svenska Vetensk.-Akad. Förhandl. 4: 16. 1848.

Geographical distribution. **PACIFIC OCEAN:** St. Augustin, west coast of Mexico (type locality, J. Agardh, *loc. cit.*); Hawaiian Islands (Chamberlain, 10, p. 33; Papenfuss in the present article); Japan (Okamura, 33, p. 26, in part); Tonga Islands (Grunow, 17, p. 50); Molucca Islands (Heydrich, 18, p. 295). **INDIAN OCEAN:** Dirk Hartog Island, Western Australia (Askenasy, 3, p. 54); South Africa (Papenfuss in the present article). **ATLANTIC OCEAN:** Puerto Rico (Thompson, 43, p. 97).

TAENIOMA MACROURUM Thuret, in Bornet and Thuret, Notes Algologiques, Fasc. 1: 69. 1876.

Geographical distribution. **MEDITERRANEAN SEA:** Tangier, Morocco (type locality, Thuret, *loc. cit.*; Bornet, 8, p. 297, as *T. perpusillum*); Balearic Islands (probably this species, De Toni, 13, p. 358, as *T. perpusillum*); Naples (Berthold, 4, p. 523; Falkenberg, 14, p. 709); Dalmatia, Adriatic (Schiffner, 39, p. 158—Alg. mar. no. 860!; 40, p. 302). **ATLANTIC OCEAN:** Canary Islands (Børgesen, 6, p. 143, as *T. perpusillum*). **CARIBBEAN:** Caracas, Venezuela (Bornet, 8, p. 297, as *T. perpusillum*), Barbados (probably this species, Vickers, 44, p. 62, as *T. perpusillum*), Bahamas (Thompson, 43, p. 97; Howe, 21, p. 564, as *T. perpusillum*, *Howe 5708*!), Virgin Islands (Børgesen, 5, p. 338, as *T. perpusillum*). **PACIFIC OCEAN:** Japan (Okamura, 33, p. 26, as *T. perpusillum*, in part).

Platysiphonia Clevelandii (Farlow) Papenfuss, comb. nov. *Taenioma Clevelandii* Farlow, Proc. Am. Acad. Arts and Sci. 12: 236. 1877.

Geographical distribution. **CALIFORNIA:** San Diego (type locality, Farlow, *loc. cit.*); San Pedro (Herb. Univ. Calif. no. 96445, *Mrs. H. D. Johnston*, Jan. 27, 1900, with tetrasporangia; no. 315651, *H. P. Johnson*, Dec. 28, 1895); Carmel Bay (Herb.

Univ. Calif. no. 274026, N. L. Gardner, May, 1916, with tetrasporangia); near Pacific Grove (Hollenberg, 19, p. 534).

DISCUSSION

From the preceding account of the structure of the thallus and the development of the tetrasporangia it is clear that Falkenberg (14) was justified in removing *Taenioma* from the Rhodomelaceae and placing it in the Delesseriaceae. Within this family the genus belongs in the sub-family Delesserieae; and from a comparison with other genera, it is apparent that *Taenioma* is the simplest of known Delesserieae. This is shown both by the structure of the thallus and the exposed condition of the sporangia. In the indeterminate branches, the lateral pericentral cells do not function as the mother-cells of lateral initials, while in the determinate branches, where they do act as such, the cell-row of the second order is composed of but two cells and that of the third order is represented by only one cell. As in other Delesserieae, the sporangial mother-cells first form a sporangium and later the cover cells; but in contrast to other members of this sub-family the cover cells in *Taenioma* are of a rudimentary character and at best can only be classed as incipient cover cells. They have no protective value at any stage in the development of the sporangia. These organs consequently always remain exposed on two sides.

In his monograph on the Delesseriaceae, Kylin (25) divided the family into a number of groups. To these was added the *Claudea*-group by Papenfuss (35). *Taenioma* possesses certain of the characters of the latter group but differs from it and all other groups in one very important feature, namely, the exogenous origin of the branches. This method of branch initiation is, however, also shown by *Caloglossa*, which Papenfuss included in the *Claudea*-group. *Caloglossa* was placed in this group on the basis of the structure of the blade and the formation of procarps on only one surface of the blades; and since it has generally been supposed that the branches in *Caloglossa* are marginal in origin, the *Claudea*-group was circumscribed so as to include forms with this method of branching. From the work of Nägeli (32) it is obvious, however, that the branches in *Caloglossa* are exogenous in origin. It thus becomes necessary to remove this genus from the *Claudea*-group, and to amend the group so as to exclude forms showing marginal branching.

Since *Taenioma* and *Caloglossa* differ from all other known Delesseriaceae by the exogenous origin of their branches, it seems likely that these genera will prove to be closely related. This question could be considered more profitably, however, after the development of the procarp and the cystocarp had been studied in both genera. It may be noted that structurally the thallus of *Caloglossa* is more complex than that of *Taenioma*.

A question which may here be considered is whether *Taenioma* exhibits a primarily simple or a reduced condition. Since the structure of the thallus, especially that of the indeterminate branches, is comparable to that of many Rhodomelaceae, the most highly evolved Florideae, it may be argued that the thallus of *Taenioma* has been reduced. None the less, the exposed state of the sporangia, coupled with the simplicity of the thallus, favors the view that *Taenioma* actually represents a primitive condition within the Delesseriaceae, that is, a genus which has retained certain relatively simple features characteristic of Ceramiales lower than the Delesseriaceae and other characters which have become elaborated or which have been eliminated in the higher Delesseriaceae.

Within the Delesseriaceae the origin of tetrasporangia from pericentral cells probably is a feature which in itself is indicative of a primitive condition. But it is difficult to evaluate this character in *Taenioma* and related genera, since the thallus is very narrow and the only other cells which conceivably could form sporangia would be the flanking cells. In none of the Delesseriaceae, however, do marginal cells form sporangia. In contrast to *Taenioma*, the sporangia in higher Delesseriaceae are formed by cortical cells and not by pericentral or other primary cells.

In view of the primitive features exhibited by *Taenioma*, it becomes of interest to know whether the genus throws light on the relationships of the Delesseriaceae. Although it is not possible to point to any particular transitional type which could be conceived as forming a link between *Taenioma* and any other family of the Ceramiales, yet certain facts have come to be recognized which have a bearing on the phylogeny of the order and which necessitate a change in the accepted view regarding the relative positions of two of the families, namely, the Delesseriaceae and the Dasyaceae.

In works on the algae, the Dasyaceae are usually placed above the Delesseriaceae. From a review of the literature and the results of the present study it is apparent, however, that the Dasyaceae are phylogenetically lower than the Delesseriaceae. Certain facts furthermore suggest that the Dasyaceae evolved from Ceramiaceae-like ancestors and that the Delesseriaceae and the Rhodomelaceae developed from Dasyaceae-like plants.

It is commonly agreed that the Ceramiaceae include the most primitive Ceramiales. This view is supported by the following facts: (1) The thallus in general is relatively simple, consisting in lower forms of branched monosiphonous filaments but becoming polysiphonous or corticated in higher forms. Typical pericentral cells, that is, cells which from the beginning are as long as the central cells, are, however, not formed. (2) In the majority of forms the sporangia and the gonimoblasts are naked.

(3) The auxiliary cell in lower forms is supplied with a diploid nucleus via an intermediary connecting cell.

Although Kylin (24, 26, 27) has on several occasions expressed the view that the Delesseriaceae and the Rhodomelaceae represent two parallel lines of development, with the Rhodomelaceae occupying a somewhat higher level than the Delesseriaceae, he has, nevertheless, always placed the Dasyaceae above the Delesseriaceae. Phycologists in general have adopted the arrangement of Kylin.

From the work of Rosenberg (38) and others on the Dasyaceae several facts may be cited which indicate that this family is less advanced than the Delesseriaceae and more closely related to the Ceramiaceae than are the Delesseriaceae. The most significant single fact supporting this view is that in the Dasyaceae the auxiliary cell receives a diploid nucleus from the fertilized carposogonium via a connecting cell. This feature is characteristic of the lower Ceramiaceae, but has been lost in the Delesseriaceae. Other primitive features of the Dasyaceae are: (1) The sporelings remain monosiphonous for a long time (Killian, 22) as contrasted with those of the Delesseriaceae and Rhodomelaceae in which pericentral cells are formed at an early stage in development. (2) The pericentral cells are of a rudimentary character in certain genera. (3) The sporangia remain partially exposed.

It may also be added that Falkenberg (14) considered the sympodial method of branching of the Dasyaceae as a character which is primitive in comparison with the monopodial branching characteristic of the Rhodomelaceae. Whether the sympodial habit actually is a primitive feature or whether it is a derived condition which has become established in the Dasyaceae would, however, be difficult to decide. It would seem that in exogenous branching a reversal from the monopodial to the sympodial habit or vice versa is one which would not entail profound change. Furthermore, in the Ceramiaceae, which are more primitive than the Dasyaceae, some forms show monopodial and others sympodial branching (Feldmann-Mazoyer, 16, p. 123).

According to Kylin (28, p. 134) the sporelings of the Dasyaceae show monopodial branching. If this were correct it would indicate that the sympodial habit of the older thallus was acquired in the course of evolution of the family. However, from the observations of Killian (22) on the sporelings of *Dasya arbuscula*, upon which work Kylin's statement is based, it seems evident that sympodial branching is also characteristic of the sporelings of the Dasyaceae, or at least of those of *D. arbuscula*. This is the interpretation which Oltmanns (34, p. 322) also gives of Killian's work.

As to the relative position of the Delesseriaceae and the Rhodomelaceae the available facts favor the conclusions of Kylin (24, 26, 27) that these families represent two parallel lines of

evolution, with the Rhodomelaceae occupying a somewhat higher level than the Delesseriaceae. In support of this view Kylin (26, 27) cites three facts: (1) The Rhodomelaceae are in a more active state of speciation. (2) In the Rhodomelaceae the pericarp is initiated prior to fertilization whereas in the Delesseriaceae it is formed after fertilization. (3) In the Rhodomelaceae, the cover cell of the procarp is a specialized cell which degenerates if fertilization fails to occur while in the Delesseriaceae it is comparable to an ordinary vegetative cell (Kylin, 24, p. 102; 28, p. 286).

It may be pointed out, however, that the two latter distinctions only hold when the Rhodomelaceae are contrasted with the Delesseriaceae. In the higher Delesseriaceae, that is, in the Nitophylleae, the cover cell of a procarp behaves like that of the Rhodomelaceae (Kylin, 28, p. 286); and in certain members of this sub-family (e.g., *Phycodrys sinuosa* Kylin, 24, figs. 46h, 47d-g; *Acrosorium acrospermum* Papenfuss, 36, fig. 16) the pericarp is initiated prior to fertilization.

To the points cited by Kylin may now be added a fourth which lends support to the view that the Rhodomelaceae are phylogenetically higher than the Delesseriaceae. In the Rhodomelaceae the sporangial mother-cells cut off the cover cells before the sporangia are initiated whereas in the Delesseriaceae the cover cells are formed after a sporangium has been initiated. In the latter group the young sporangia are thus exposed while in the Rhodomelaceae they are protected. In *Taenioma*, the most primitive of known Delesseriaceae, the cover cells are rudimentary and serve no protective purpose at any stage in the development of the sporangia, while in the related *Platysiphonia* the cover cells are well developed on one surface of the fertile branches and rudimentary on the other. Thus *Platysiphonia* may be said to form a link between *Taenioma* and *Vanvoorstia* in which latter genus the cover cells are well developed on both surfaces of the fertile blades (Papenfuss, 35).

As to the probable ancestors of the Delesseriaceae, there is reason to believe that they may have evolved as an off-shoot from the stock which gave rise to present-day Dasyaceae. Three facts especially may be cited in support of this view: (1) In the Delesseriaceae as in the Dasyaceae the sporangial mother-cells first form a sporangium and then the cover cells. (2) In both the Delesseriaceae and the Dasyaceae the cover cell of the procarp is comparable to a vegetative cell and functions as such if fertilization fails to occur. (3) In the Delesseriaceae in general, but more particularly in the Delesseriaceae, as well as in the Dasyaceae the pericarp is not initiated until after fertilization.

It is of interest to note that in these three features the Rhodomelaceae have advanced beyond both the Dasyaceae and the Delesseriaceae. It may be mentioned, however, that the higher

Delesseriaceae, for example, certain members of the Nitophylleae, not only share some of these advances with the Rhodomelaceae but have attained a degree of simplicity which surpasses that shown by any of the Rhodomelaceae. It is thus found that: (1) In the Nitophylleae growth of the mature thallus is usually marginal whereas in the Rhodomelaceae it is primarily apical. (2) In the Nitophylleae intercalary cell divisions are of common occurrence while such divisions, to the writer's knowledge, are unknown in the Rhodomelaceae. (3) In the Nitophylleae the reproductive organs are formed in parts away from the central axis of the thallus whereas in the Rhodomelaceae they generally are localized on the axis, that is, the pericentral cells. It is of interest to note that an advance in the same direction is shown by some of the higher Rhodomelaceae, such as *Laurencia* and *Ricardia*. In these genera the sporangia are no longer formed by pericentral cells but by cells farther away from the central cells (cf. Kylin, 26, p. 101).

Finally, in regard to the probable prototypes of the Rhodomelaceae, it seems likely that this family also may have evolved from Dasyaceae-like algae, although at a time subsequent to the separation of the Delesseriaceae. It is well known that the Rhodomelaceae have a number of characters in common with the Dasyaceae. The similarity in the habit of the thalli, the formation of the sporangia from pericentral cells, and the corresponding position of the spermatangia are some of the more important points of agreement which may be mentioned. It is of interest to note in this connection that in *Heterosiphonia coccinea* (Dasyaceae) the pericentral cells are formed in the manner characteristic of the Rhodomelaceae except in the fertile segments of female plants where they are formed in typical dasyacean fashion (Rosenberg, 38). In this particular species the sporangia and their cover cells are also formed in the sequence characteristic of the Rhodomelaceae. This member of the Dasyaceae thus shows certain morphological features which have become established in present-day Rhodomelaceae. It may further be mentioned that Falkenberg (14) considered the Dasyaceae, as now recognized, as a sub-family in the Rhodomelaceae and regarded them as the ancestors of all other Rhodomelaceae.

A schematic representation of the probable interrelationships and lines of development of the families of the Ceramiales is given in text figure 1.

SUMMARY

The results of this study show that *Taenioma* does not belong to the Rhodomelaceae, in which it has been placed by certain writers, but to the Delesseriaceae. This is shown by the plan of pericentral cell formation, the manner of division of the lateral

pericentral cells, and the method by which the sporangia are formed.

From the simple structure of the thallus and the exposed condition of the sporangia, it is concluded moreover that *Taenioma* is the simplest of known genera of the Delesseriaceae.

The branches of *Taenioma* are exogenous in origin. Although characteristic of the other families of the Ceramiales, this method of branching is rarely encountered in the Delesseriaceae and in addition to *Taenioma* is known to occur in *Caloglossa* only.

The sporangia are initiated by the lateral pericentral cells and are formed before the mother-cells have cut off cover cells. The latter feature is recognized as one whereby the Delesseriaceae

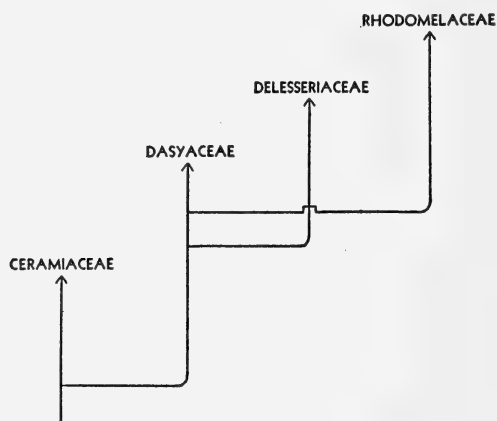


FIG. 1. Diagrammatic representation of the probable interrelationships of the families of the Ceramiales.

may be distinguished from the Rhodomelaceae. In the Rhodomelaceae the mother-cells first form cover cells and then a sporangium.

Taenioma perpusillum and *T. macrourum* are considered as separate species. The primary distinguishing feature lies in the fact that the determinate branches of the former form three and those of the latter two terminal hairs. These hairs are initiated in a precise manner by the apical cell and do not vary in number.

Taenioma Clevelandii, the only other species which has been credited to *Taenioma*, is transferred to the genus *Platysiphonia* with which it is shown to share various morphological features.

The phylogeny of the Ceramiales is discussed. Evidence is produced to show that the Delesseriaceae are more highly evolved than the Dasyaceae. Additional evidence is furnished in support of the view of Kylin that the Rhodomelaceae are the most highly evolved Ceramiales. It is concluded that the Dasyaceae evolved

from Ceramiaceae-like and the Delesseriaceae and Rhodomelaceae from Dasyaceae-like ancestors.

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After the study had been completed, it was learned from Dr. C. K. Tseng that he had also been working on *Taenioma*, and had arrived at the same conclusions as the writer with respect to the systematic position of the genus and the taxonomy of the species.

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NOTES ON THE ALGAL GENUS TAENIOMA¹

C. K. TSENG

The algal genus *Taenioma* (Delesseriaceae, Rhodophyceae) was founded by J. G. Agardh (2, p. 1256) on *Polysiphonia perpusilla* which he (1, p. 16) himself previously had described from material collected by Liebmann at St. Augustin on the Pacific coast of Mexico. The then monotypic genus was characterized by (1) a filiform, dichotomously branched frond with polysiphonous, articulate, noncorticate filaments; (2) the presence of marginal cells half the length of the segments on the flattened portion of the frond; and (3) dilated, vittiform stichidia bearing tetrasporangia (then known as sphaerospores) in a double series. The genus was placed by its author, together with *Sarcomenia*, in the tribe Sarcomeniae which was then placed in the family Rhodomelaceae but later more properly removed by Schmitz (19) to the Delesseriaceae.

Thuret (7, p. 69, pl. 25) added another species to the genus, namely *Taenioma macrourum*, citing as a synonym *Hutchinsia macroura* Schousboe in herb. The type material came from Tangier, Morocco, in the Mediterranean. Not having seen J. Agardh's specimen of *T. perpusillum* Thuret, in describing his species, expressed some doubt as to the specific difference between the Mediterranean form and the one from the Pacific. In keeping the two separate, he was probably influenced by the widely separated regions from which the two plants were collected, some apparent differences in size and color, and especially the presence in the Mediterranean plant of two apical hairs which were presumably absent in the alga from the Pacific. It should be noted, however, that J. Agardh, *op. cit.*, did mention the presence of apical hairs in his plant: "Stichidium . . . apice saepe in fila minuta 3 . . . excurrens." Examination of Agardh's type specimen by Howe (*in* Thompson, 21, p. 98) has confirmed this. The writer has also examined a fragment of the original specimen deposited in the herbarium of the New York Botanical Garden and is in perfect agreement with Howe.

Several years after the publication of *Taenioma macrourum* Thuret, Bornet (6, p. 297) examined a specimen of *T. perpusillum* J. Ag. and came to the conclusion that the Pacific and the Mediterranean plants are not separable specifically. Later, Heydrich (12, p. 295) and De-Toni (9, p. 732) adopted Bornet's view. Schmitz and Hauptfleisch (20, p. 415), however, retained both species. In his classical work on the Rhodomelaceae, Falkenberg (10, p. 709, pl. 15, fig. 21-29), devoted some space to the morphology of the Mediterranean plant, which he separated from the Pacific alga chiefly on the basis of its having long monosiphonous

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apical filaments on the flattened "leaves," presumably absent in *T. perpusillum* J. Agardh. This, as already pointed out above, is not correct. Falkenberg also mentioned that the two species differed in the nature of the branches. He remarked that in the Mediterranean plant the cylindrical segments of the side branches and also those of the axis between two branches were so short and compact that it was easily distinguishable from the Pacific plant, which was much slenderer and more loosely branched. While it is true that the Pacific alga has much longer side branches, the shortness and compactness of the segments are similar in both cases. It is no wonder, therefore, that later authors (cf. Collins and Hervey, 8, p. 117; Børgesen, 4, p. 341; and Okamura, 17, p. 26) in trying to differentiate the two species on this basis, could not see the desirability of keeping them apart.

Thompson (21) published a detailed study of the morphology of *Taenioma*, using two different sets of materials collected by Howe at Porto Rico (Puerto Rico) and at West Caicos in the Bahamas. She was probably the first to note some of the important differences between *T. perpusillum* and *T. macrourum* although she discussed both forms under the latter name. Such differences between these two collections as the branching and the number of apical hairs and segments in the flattened shoots have been correctly emphasized. In an editorial note in Thompson's paper, Howe justified that author's identification of the Bahamian plant with the Mediterranean species. He questioned, however, "the identity of this *T. macrourum* with the previously described *Taenioma perpusillum* of J. Agardh . . .," remarked that his Puerto Rican plant and the type of J. Agardh's species from Mexico are "essentially the same except that the terminal hairs are much longer and more luxuriant in the Porto Rican plant," and concluded that he was "inclined to agree with Bornet . . . with Heydrich . . . and with De-Toni . . . in considering *Taenioma macrourum* (Schousb.) Thur. a synonym of *Taenioma perpusillum* J. Ag."

Howe seemed to have regarded the differences of these two sets of specimens, which he considered to belong to the same species, as a matter of ecological influence. He made the remark that the Bahamian plants "were found growing in an inland pond or lake, having evidently a subterranean communication with the sea—a place where several marine algae of recognizable species were more or less abnormal and peculiar," and the Puerto Rican plants "were growing where they were well exposed to the surge of the open sea." It should be noted, however, that Børgesen (4, p. 341), whose plant was evidently of the same species as Howe's from the Bahamas, found it "in an open place upon reefs of calcareous algae, etc."

To date, phycologists seem to have regarded this problem of the *Taenioma perpusillum-macrourum* complex as satisfactorily

settled, have generally adopted the view of Bornet and his followers, and have conventionally put *T. macrourum* as a synonym of *T. perpusillum* whenever that species is reported.

The third species of *Taenioma* was described by Farlow (11, p. 236) on material from San Diego, California, and was named *Taenioma Clevelandii*. As described, it "has scattered stichidia, is four inches high, and has a striking resemblance to *Griffithsia tenuis* Harv.," and its "stichidial branches terminate in a more or less acute apex instead of two hairs." It was also mentioned that "in the lower part of the frond, the angles between the primary cells are filled with a small but irregular number of secondary cells." All these peculiarities are certainly very different from the characteristics of the *Taenioma perpusillum-macrourum* complex and the writer has long doubted its being a member of this group. He has studied some specimens collected at Moss Beach, Pacific Grove, California (Hollenberg 3228) and is fully convinced that it should be separated from *Taenioma*.

Recently Hollenberg (13, p. 534) has pointed out several additional differences between *Taenioma Clevelandii* Farl. and *T. perpusillum* J. Ag., although he still preferred to keep the Californian plant in the same genus. Dr. Papenfuss who has made a critical study of *Taenioma Clevelandii* has agreed with the writer that it does not properly belong to *Taenioma*. He has further decided that it should be transferred to the genus *Platysiphonia* Børg., because (1) its branches are endogenous in origin; (2) it does not form terete branches; (3) it does not have determinate branches ending in hairs; and (4) its tetrasporangial branches have a dorsiventral organization, since the stalk cell of a tetrasporangium forms a large cover cell on one surface and a rudimentary one on the other. These characteristics are so fundamentally different from those of *Taenioma*, that there should no longer be doubt among phycologists that the plant from San Diego should be removed from the genus *Taenioma*.

Some years ago, the writer gathered from Hong Kong a collection of a *Taenioma* rich in tetrasporangia. At first, he was inclined to follow others and consider *T. macrourum* Thur. a synonym of *T. perpusillum* J. Ag. The more the specimens and literature were studied, however, the more hesitant he was to do so. After a thorough study of his collection, which has been preserved in excellent condition for microscopic examination, and the extensive collections of Howe, including some fragments of the type specimen of *T. perpusillum* J. Ag., deposited in the Herbarium of the New York Botanical Garden, the conclusion was finally arrived at, that the differences, especially those reported by Thompson and Howe, do exist, and are very constant. Other differences have also been found. The fact that the same form has been reported to occur in sheltered and exposed places and both forms in more or less similar situations naturally eliminates

the possibility of their being ecological forms, at least, so far as the factor of the relative exposure to surf is concerned. Furthermore, the geographical distribution of *T. perpusillum* and *T. macrourum* gives evidence of their distinctness. When fundamental differences between these two forms are constant and

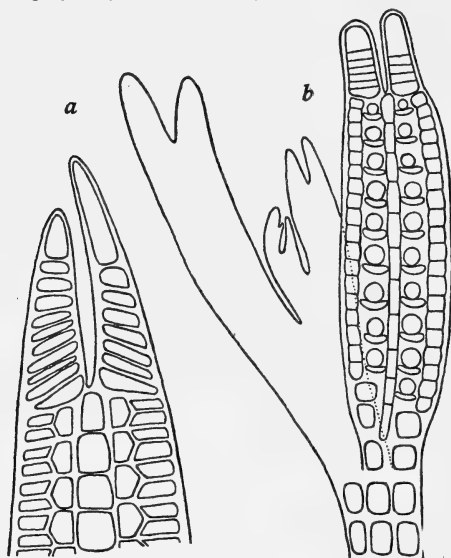


FIG. 1. *Taenioma macrourum* Thuret: *a*, apex of a branchlet showing the two apical hairs, $\times 560$; *b*, upper part of a branch showing a stichidium, $\times 190$.

without intermediates, and when these cannot be traced to ecological or geographical influences, then there is no alternative than to accept the two forms as separate, independent species.

The most important difference between the two lies in the number of apical hairs. The Puerto Rican and Hong Kong specimens always have three apical hairs on the flattened branchlets and are referable to *T. perpusillum* J. Ag. There are many determinate branchlets which at a glance seem to have only two hairs. A careful study, however, reveals the fact that the oldest hair in the group of three has already dropped off, and the two younger ones are left behind (pl. 25, fig. 5). The Bahamian, Bermudian, and Mediterranean specimens as well as the Japanese plants described and illustrated by Okamura (17, p. 26, pl. 244, fig. 17-19, pl. 245, fig. 5-9, on the contrary, have only two hairs and undoubtedly belong to *T. macrourum* (text fig. 1a). To be sure, Okamura (17, p. 27, pl. 265, fig. 8) mentioned and figured a branchlet with three apical hairs. Whether this was an abnormal form of the normally two-haired plant, or whether Okamura had both species, can be settled only by examination of his specimens which had come from at least two different sources.

The presence of two or of three such apical hairs is neither accidental nor irregular. It is rather a matter of fundamental difference traceable to the behavior of the apical cells of the determinate branchlets. In *T. macrourum*, the apical cell, after having formed the more or less definite number of segments, gives rise by an oblique division to a hair-initiating cell. Later, the apical cell itself assumes the role of hair formation, thus resulting in two hairs (text fig. 1a). In the case of *T. perpusillum*, the apical cell by alternate oblique divisions forms two hair-initials.

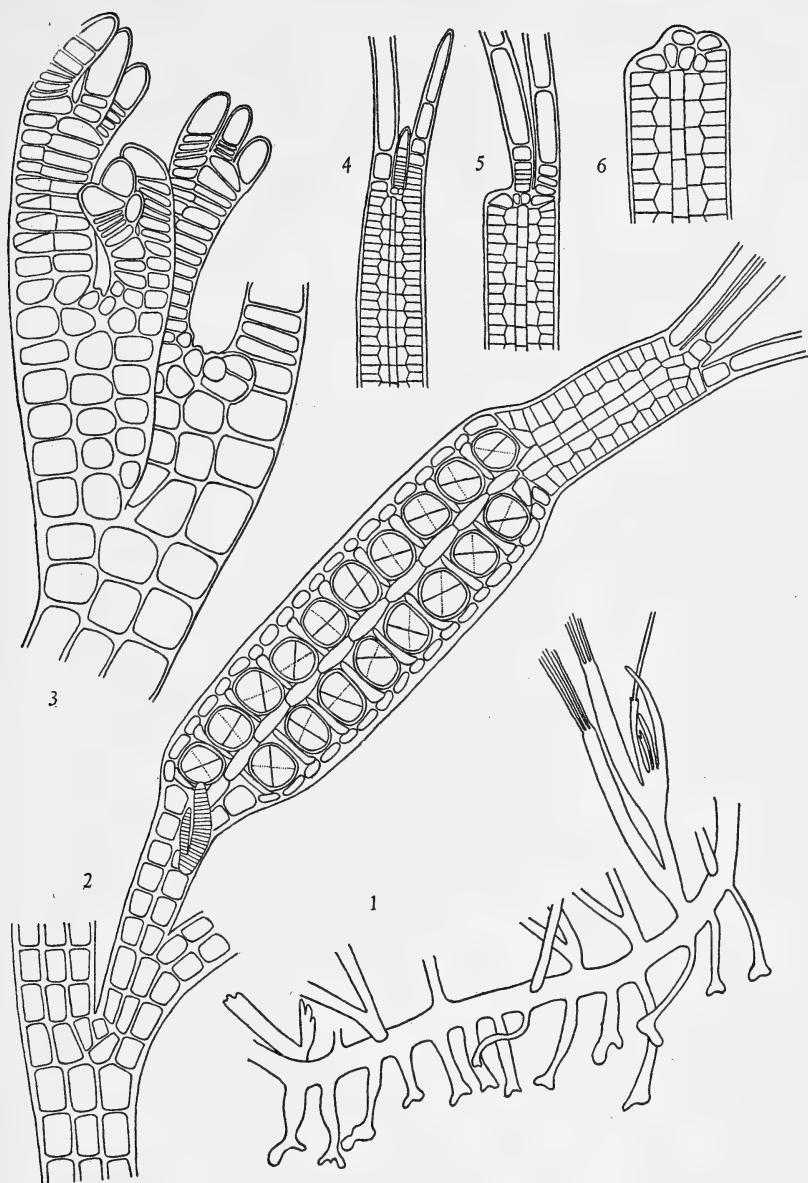


PLATE 25. *TAENIOMA PERPUSILLUM* (J. Agardh) J. Agardh. FIG. 1. Habit sketch of a portion of a young plant, $\times 32$. FIG. 2. A part of an erect branch, showing a stichidium with tetrasporangia, the differentiation of fertile and sterile portions, and the apical hairs, $\times 155$. FIG. 3. Apical part of a branch showing the apical cells, $\times 452$. FIG. 4. A young branchlet with three hairs in different stages of development, $\times 155$. FIG. 5. An older branchlet with one hair dropped off and two remaining, $\times 155$. FIG. 6. An old branchlet with all three hairs dropped off, leaving three basal cells of the hairs behind, $\times 155$.

One of these develops faster than the other, resulting in two hairs of unequal length. Later the apical cell also gives rise to a hair, resulting in the three terminal hairs characteristic of this species (pl. 25, figs. 2, 3 and 4). In the younger branchlets, while all three hairs are found, the central one generally remains shortest (pl. 25, fig. 4). In older branchlets, the first-formed lateral hair may have dropped off, leaving its basal cell in the original position, while the two which develop later, remain (pl. 25, fig. 5). Then, the other lateral hair and at last the central one drops off, leaving the three basal cells of the original hairs behind. The branchlet at this stage appears stunted, blunt and hairless at the apex (pl. 25, fig. 6). This explains why sometimes there appear to be only one or two hairs, or even hairless forms, instead of the three hairs as described.

Another important difference, already pointed out by Thompson, *op. cit.*, lies in the respective number of segments in the flattened determinate branchlets of these two species. In *T. perpusillum*, there are generally 20 to 35 segments, occasionally as few as 15, and the length of the mature branchlets varies from 0.6 to 1.0 mm. In *T. macrourum*, there are many fewer segments, generally 8 to 20 only, rarely more, and the branchlets are correspondingly shorter, being about 0.25 to 0.40 mm. long when fully mature. In dealing with the length of the branchlets, it is to be noted, the hairs are not included.

There are also observed some differences in the stichidia. In *T. perpusillum*, the stichidium has a cylindrical stalk of 3 to 5 segments followed by the broadened, fertile portion of the "blade" composed of varying numbers of 8 to 14 segments (sometimes as few as 4 and sometimes as many as 17) and then a narrower, sterile portion of 6 to 12 segments upon which are the monosiphonous hairs. Sometimes there are also a few sterile segments between the stalk and the fertile segments (pl. 25, fig. 2). In *T. macrourum*, the cylindrical stalk, with only one or two segments, is followed by the broadened, fertile "blade" and then terminates in the hairs, without an intervening sterile portion as in *T. perpusillum* (see text fig. 1b). This difference between the two species is found in the materials examined. However, in a recent communication Dr. Papenfuss remarks that in his material of *T. perpusillum* the tetrasporangia very frequently extend distally up to the hair-forming segments.

The two species, as they are now separated by the writer, also differ from each other in habit. Generally speaking, *T. perpusillum* is more closely and conspicuously fasciculate, the branching often fastigiate and the branchlets usually alternately disposed, whereas in *T. macrourum*, the branchlets are more loosely disposed and usually secund. In the former species, the erect branches are much taller, about 2 to 3 or more millimeters high, and have as many as twelve determinate branchlets. The latter species has

the erect branches about 1 mm. or less high, with generally 4 to 5 determinate branchlets each.

The original description of the genus by Agardh and the subsequent descriptions of others such as Schmitz and Hauptfleisch are far from complete. Many of the important facts about this group of plants, especially with regard to the sexual organs, were discovered much later. It is Thompson (21) to whom we must turn for our present knowledge of the development of the male organs and the general characteristics of the cystocarps; unfortunately there is no detailed account of the developmental phases of these structures. Collins and Hervey (8, p. 117) mentioned that they found a cystocarp which was, however, lost before a drawing and a description could be made.

By bringing together the collections studied by previous authors and studying these in connection with our own, the following revised description of the genus is made possible.

TAENIOMA J. Agardh (1863). Plants dorsi-ventral, with horizontally creeping, cylindrical, segmented, polysiphonous, ecorticate, main filaments rhizomatous, giving rise to stout, unicellular rhizoids below and erect branches above. Erect branches arising at rather regular intervals, secundly or alternately, pseudodichotomously branched. Determinate branchlets with short, cylindrical, polysiphonous segmented stalks and flattened, segmented, distal portions. The flattened portion with a distinct midrib of a central siphon surrounded by four pericentral siphons. The dorsal and ventral pericentral cells smaller and the lateral ones larger, each giving rise to two marginal cells, which are very regularly, transversely arranged at the periphery. Apical parts of the determinate branchlets provided with colorless, monosiphonous filaments (hairs). Apical cells large, dome-shaped, dividing by transverse walls. Growth monopodial. Branching exogenous. Tetrasporangia originating from lateral pericentral cells, with two rudimentary cover cells, tetrahedrally divided, in two rows, one on each side of the midrib of the fertile branchlets. Spermatangial branchlets flattened, similar to the tetrasporic ones, fertile portions broadened, spermatangia developed upon cells between axial and marginal cells. Cystocarps urceolate with a terminal ostiole, developed from modified branches.

The general habit of members of this genus is like that of *Herposiphonia* of the Rhodomelaceae, with a horizontally creeping filament giving rise to erect branches at rather regular intervals. The division of the apical cells and the mode of growth are similar to the genus *Caloglossa*. The apical cell repeatedly cuts off disc-like cells below until a more or less definite number is reached and then divides by an oblique wall into two unequal parts (pl. 25, fig. 3). The upper part continues as the apical cell of the filament while the lower, dividing by an oblique transverse wall perpendicular to the first, gives rise to another dome-shaped

cell which becomes the apical cell of the new lateral branch. It follows that the branching is strictly lateral, rather than dichotomous as claimed by J. Agardh, although it may appear subdichotomous. Each segment consists at first of a single disc-like cell, which soon gives rise to two cells on the right and left by two longitudinal divisions, thus forming three cells of similar shape and size in the same plane. Then, two other longitudinal divisions occur, parallel to each other, but perpendicular to the first divisions, thus giving rise to two more cells, one dorsally and one ventrally. The segment thus formed is similar to a typical *Polysiphonia* in having a central cell surrounded by four pericentral cells. The segments of the main filaments, the axis of the branches and the stalks of the determinate branchlets always remain this way. In the distal part of the determinate branchlet, however, the two lateral cells each again undergoes two divisions: first an oblique wall cutting off a triangular cell in the upper part and then a second division cuts off a similar cell in the lower part, thus forming two marginal cells of exactly half the height of the pericentral cells.

In the formation of the tetraspores, each of the lateral pericentral cells undergoes a transverse division, the upper cell becoming the sporangium and the lower one the stalk cell. The sporangium enlarges greatly, still always retaining protoplasmic connection with the stalk cell, and, dividing thrice: a longitudinal division parallel to the flat surface, a transverse one and a third perpendicular to both divisions, give rise to a tetrahedrally divided sporangium (pl. 25, fig. 2). The stalk cells eventually form two cover cells on both surfaces.

Falkenberg (10) mentioned and figured what he suspected to be "antheridia." These are now known to be malformations. Schmitz and Hauptfleisch (20) were the first to correctly mention the spermatia as occurring between the midrib and the marginal cells. Their development was reported by Thompson (21) and the writer's investigations substantiate her conclusions. Briefly, the marginal cells are the first to divide longitudinally; the outer ones remain as such while the inner become the spermatangial clusters by repeated divisions. Later, the pericentral cells on both sides of the axial cells also become involved. Thus, in the fertile portion, all of the cells between the marginal cells and the axial ones give rise to spermatangia. Either the entire "blade" or a part of it becomes fertile. The stalk and the apical hairs remain sterile.

Cystocarps, so far, have been described only by Thompson, *op. cit.* The writer has found, in the Bermuda material, a single urceolate, ostiolate cystocarp with rather broad base and conspicuous neck. Being among crowded filaments in a permanent mount, it cannot be studied in detail. According to Thompson, the characteristics of the cystocarps are those of the *Rhomomela*-

ceae into which family she preferred to place the genus. It seems that further investigations with better materials are necessary in order to solve this problem. But since the vegetative characteristics as well as those of the tetrasporangia and spermatangia show much closer relationships with such plants as *Sarcomenia* and *Caloglossa*, the writer is inclined to follow Falkenberg, Schmitz, and others in placing this genus in the family Delesseriaceae. Papenfuss (MSS) has arrived at this same conclusion as to the taxonomic position of the genus.

As mentioned above, the genus with its two species is reported from various tropical and subtropical regions, although such records are rather meagre. It seems likely that its distribution is very extensive in warmer waters. The two species can readily be distinguished from each other by sterile characters alone:

- | | |
|--|--------------------------|
| A. Plants to 2-3 mm. high, flattened determinate branch- | |
| lets with 15 to 30 segments, apical hairs three | 1. <i>T. perpusillum</i> |
| AA. Plants less than 1 mm. high, flattened determinate | |
| branchlets with 8 to 20 segments, apical hairs | |
| two | 2. <i>T. macrourum</i> |

1. *TAENIOMA PERPUSILLUM* (J. Agardh) J. Agardh, Sp. Alg. 2(3): 1257. 1863. *Polysiphonia perpusilla* J. Agardh, Öfvers. Kgl. Svenska Vetensk.-Akad. Förhandl. 4: 16, 1848. *Taenioma macrourum* Thompson *non* Thuret, Bull. Torrey Bot. Club 37: 97, pl. 9, f. 12, pl. 10. 1910. (In part.)

In a note deposited in the herbarium of the New York Botanical Garden, Howe remarked that the type of this species was mostly sterile, differing considerably in habit from his tetrasporic collection (no. 2433), but a tetrasporic plant in the type collection was similar. The principal material upon which Thompson based her morphological study of the genus (*Howe 2433*) was growing on a stick of wood collected near low-water mark, at Point Borinquen near Aquadilla, Puerto Rico on June 15, 1903. This material is rich in tetrasporic and spermatangial branchlets; occasionally what seem to be young cystocarps may also be observed.

The Hong Kong materials (*Tseng 2857*) were found tufted on an exposed, surf-beaten rock, together with various small algae, such as *Herposiphonia caespitosa* Tseng, *Gelidium pusillum* (Stackh.) Le Jol., in the lower littoral region at Shek-O, Hong Kong I., on July 4, 1940. They are all tetrasporic. The primary filament is about 90 to 110 μ in diameter, with the segments shorter than the breadth, about 60 to 75 μ long. It sends down vigorous, stout unicellular rhizoids, to as much as 75 μ in diameter, separated from the mother pericentral cells by transverse walls, and more or less expanded at the ends (pl. 25, fig. 1). Erect branches arise from the decumbent filament quite regularly at intervals of 5 to 9 segments. Their axes are cylindrical and segmented like the main filament, giving rise to minor branches or branchlets alternately and fastigiately. The determinate branchlets with cylindrical

stalks below and flattened "blades" above, terminate in three long monosiphonous hairs. The stalks are cylindrical and composed of 3 to 4 segments, about $45\ \mu$ in diameter. The blades have conspicuous midribs, to about $70\ \mu$ broad when sterile and 0.6 to 1.0 mm. long, generally with 20 to 30 segments. The hairs are about $20\ \mu$ in diameter below. The stichidia are very much broadened in their fertile portions, to about $110\ \mu$ broad, otherwise like the ordinary branchlets. The tetrahedrally divided tetrasporangia are disposed in two rows along the axis, generally 8 to 14, although fewer or more have been observed. They are about $50\ \mu$ in diameter when mature (pl. 25, fig. 2).

A specimen collected by Grunow without giving the date or locality, and another from Tongatabu (Friendly Is.) by Dr. Graeffe all belong here. Heydrich (12) reported that his specimen from Batjan I., North Molucca, had two or three hairs on the stichidia. Most probably, he had this species before him. Askenasy (3) records *T. perpusillum* from Western Australia and Reinbold (18) records it from Sumatra, both without description. In view of the wide occurrence of this species in the Pacific, these identifications are probably correct.

This species, as herein limited, is known from the following regions: St. Augustin, Pacific coast of Mexico (type locality); Fiji and Friendly Is.; Western Australia; Molucca Is.; Sumatra; Hong Kong, China; and Puerto Rico, West Indies.

2. *TAENIOMA MACROURUM* Thuret, in Bornet and Thuret, Not. Alg. 1: 69, pl. 25. 1876. (In part.) *Polysiphonia nana* Kützinger, Tab. Phyc. 13: 10, pl. 29, fig. e-f. 1863. *Taenioma perpusillum*, as interpreted by Bornet (6), De Toni (9), Collins and Hervey (8), Børgesen (4), Howe (15), Okamura (17), *non* Agardh.

Since Miss Thompson (21) based her conclusions to a considerable extent upon material collected at West Caicos in the Bahamas (*Howe 5708*) it is of interest to consider the character of these specimens in some detail. The material is tetrasporic with the main filaments generally 60 to $75\ \mu$ in diameter and with segments as long as broad. The rhizoids are about $30\ \mu$ in diameter. Erect branches are short, less than 1 mm. high, arising in intervals of 4 to 6 segments. They are more loosely and secundly branched than those of the above species. The determinate branchlets have short cylindrical stalks of 1 or 2 segments and "blades" about 60 to $75\ \mu$ broad and 240 to $400\ \mu$ long (excluding hairs), with 8 to 15 segments and terminating in two colorless, monosiphonous hairs about 25 to $30\ \mu$ in diameter at the base. The stichidia are quite young, about 80 to $90\ \mu$ broad, with short stalks of 1 to 2 segments, and "blades" having all segments fertile and terminating in two hairs like the vegetative ones.

Another specimen (*Hervey 7433*), collected from South Shore, Bermuda, on February 3, 1913, has vegetative characteristics

similar to the above. There is found, among crowded filaments on a semipermanent mount, a cystocarp which is broadly urceolate, about $360\ \mu$ broad and $480\ \mu$ long, including a neck about $120\ \mu$ long. There is another Bermudian specimen (*Phyc. Bor.-Am. no. 1935*), collected by Hervey, "forming a gelatinous mass with other algae, Bigget Island, April 1913." This, according to Howe (14, p. 518) "shows a small Rhodomelaceous plant bearing some slight resemblance to the *Taenioma*." The writer, however, has found a few fragments of the determinate branchlets of *T. macrourum* Thur. sparsely scattered among a large mass of a blue-green alga and the Rhodomelaceous plant Howe mentioned. They are sterile.

Taenioma macrourum has been recorded from the following regions: Tangier, Morocco (type locality) and Naples in the Mediterranean; Canary Is.; Bermuda and West Indies; Japan; ? Cape of Good Hope.

SUMMARY

A general historical, morphological, taxonomic and distributional survey of the delesseriaceous genus *Taenioma* J. Agardh is given. *T. perpusillum* (J. Agardh) J. Agardh, described from the Pacific coast of Mexico, and *T. macrourum* Thuret, from the Mediterranean, have been regarded, in the past, as belonging to the same species. The conclusion is reached that they represent two distinct species. Important differences are found in the number of apical colorless monosiphonous hairs, the number of segments in the determinate leaf-like branchlets, the stichidia, and the habit and branching of the erect branches. Geographically, both species seem to be widely distributed and are represented, at least in one instance, in the same region (West Indies). A new locality for *T. perpusillum*, namely, Hong Kong on the China coast, is reported.

The writer wishes to express his thanks to Dr. Fred J. Seaver, Head Curator of Herbarium, New York Botanical Garden, for placing the entire collection of *Taenioma* at his disposal, and to Dr. George F. Papenfuss and Dr. Herbert L. Mason of the Department of Botany, University of California, for a critical reading of the manuscript and for making valuable suggestions. The major part of this study was made during the tenure of a fellowship in the Horace H. Rackham School of Graduate Studies, University of Michigan.

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University of California, La Jolla,
March, 1944.

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REVIEWS

Marine Algae of the Monterey Peninsula. By GILBERT M. SMITH. Stanford University Press. vii + 622 pages, 98 plates. 1944. \$6.00.

The appearance of a flora in a field in which there are less than half a dozen modern treatises is an event of first importance. Professor Smith has filled one of the outstanding gaps in our knowledge of marine phycology. Since the Monterey flora includes 80 per cent of the known seaweeds of the Pacific Coast of the United States, the importance of the book is much greater than the title suggests. Furthermore this locality is of especial historic interest as the type locality of approximately a quarter of the species described from this coast.

That the northeastern Pacific possesses a rich, varied and in some ways unique seaweed flora has been known for a long time. Setchell and Gardner have given excellent accounts of the Cyano-

phyceae, Chlorophyceae and Phaeophyceae but they did not live to complete their work on the red algae. Therefore the present section on the Rhodophyceae as the first comprehensive account, represents a most notable and definite contribution to organized algological knowledge, especially since the red algae constitute between 40 and 50 per cent of the total number of species of green, brown, and red algae occurring along the west coast of the United States.

In the introduction a brief historical sketch is given of seaweed collecting in the Monterey area, from the time of Menzies' visit during 1792-93 up to the death of Gardner in 1937. The annotated list of old and new place names will prove invaluable to future collectors in view of the fact that in a given region so many species appear year after year only along a certain stretch of shore or even on a particular rock. Other topics which are briefly discussed in the introduction include the Monterey and Pacific Coast distribution of algae in relation to ecologic factors, and instructions in seaweed collecting.

In a field which has become as technical as phycology, the adoption of a uniform terminology goes far toward a simplification of the subject matter. The skill with which this has been accomplished would be hard to improve upon. In pursuit of such uniformity the author has, however, borrowed a few terms whose adoption for the algae is open to criticism. Thus for example he has followed Pascher in using the terminal component *-phyta* in the place of *-phyceae* in the divisional names of the algae. Terminations derived from *φῶκος* not only have a precise meaning but are so old and well established in algological literature that their suppression in favor of the less precise *-phyta* is to be regretted. We thus have Chlorophyta (green plants), Phaeophyta (brown plants), Rhodophyta (red plants), instead of Chlorophyceae (green algae), Phaeophyceae (brown algae), and Rhodophyceae (red algae). If by adopting Pascher's terms we had arrived at a uniform terminal component for all divisions of plants, this might justify the *-phyta* ending. This is not achieved, however, since the fungi, gymnosperms and angiosperms were designated by Professor Smith at least as recently as 1938 as Eumycetae, Gymnospermae and Angiospermae, respectively. The divisional names in *-phyta* moreover lead to certain unnecessary inconsistencies in systematic arrangement. Thus the author recognizes a single class (Chlorophyceae) in the marine green algae, three classes (Isogeneratae, Heterogeneratae and Cyclosporeae) in the brown algae and one class (Rhodophyceae) with two subclasses (Bangioideae and Florideae) in the red algae. If one is to accept a class Chlorophyceae in the green algae and a class Rhodophyceae in the red algae, there would be equal justification for a single class Phaeophyceae in the brown algae. It would be futile to attempt to correlate the different categories of the various divisions of

algae. Nevertheless there is little ground for believing that the differences between the Bangioideae and Florideae in the Rhodophyceae are of lesser magnitude than those between the Iso-generatae, Heterogeneratae and Cyclosporeae in the Phaeophyceae, or that the three latter deserve the rank of class while the two former remain subclasses.

Similarly, little is to be gained by substituting Blakeslee's terms homothallic and heterothallic for the old and generally used terms monoecious and dioecious. Even isogamous algae usually show a physiological anisogamy and the male and female thalli can be separated on the basis of the different behavior of their gametes.

Probably in no other group of plants are details of the life history so intimately linked with classification as in the algae. Hence it does not seem out of place to consider briefly two instances of morphological interpretation in the brown algae to which the reviewer takes exception.

Owing to the extremely doubtful results of a few investigators in regard to the behavior of the zoids from the pleurilocular organs of *Ilea*, *Colpomenia* and *Scytosiphon* the author takes a non-committal stand with reference to the nature of the macroscopic thalli in these genera. There seems to be little reason, however, for questioning their asexual or sporophytic character. If the plants were gametophytes and the zoids from the plurilocular organs gametes, it is to be expected that a generation forming unilocular sporangia, the seat of the reduction division in this group of brown algae, would be formed at some phase in the life cycle. Although these genera are found in many parts of the world and have been studied extensively both from field collections and in culture, they have never, as far as the reviewer is aware, been known to form unilocular sporangia. The evidence is overwhelmingly in favor of the conclusion that the thalli represent the sporophytic generation, that sexuality has been lost entirely in these genera, and that the plants reproduce themselves only by zoöspores from plurilocular sporangia.

The author refers to the eggs and sperms of the Fucales as macrospores and microspores, respectively. Although the evolutionary origin of the reproductive organs of the Fucales is still unknown, there is little justification for considering the eggs and sperms as the equivalent of spores. In the female sex organs meiosis is always followed by one series of mitotic divisions, resulting in the formation of eight haploid nuclei, while in the male organs meiosis is followed by four or five series of divisions, resulting in the formation of 64 or 128 nuclei. The contents of the mature reproductive organ may thus be looked upon, in the opinion of Strasburger, as a reduced gametophyte of which all the functional nuclei have become separated as gametes. According to this interpretation, which apparently is the one accepted by

the author, the four nuclei formed in consequence of meiosis would be the only equivalent of spores in the Fucales.

In the systematic arrangement and in the descriptions, the author has taken account of the many recent advances in our knowledge of the structure and reproduction of the algae. The green algae are classified according to the system previously published by the author while in the brown and red algae the systems of Kylin are adopted. The same general plan is followed with respect to the treatment of the three major groups. In each case the divisions are characterized and keys and descriptions are given to the classes, orders, families, genera and species. The authors and dates of publication of the genera are given as well as the more important references on their structure and reproduction. For the species, in addition to the description, the Monterey and Pacific Coast distributions are given, and where necessary remarks on the biology or other matters of a critical nature. The citations of literature for the species include those to the more important synonyms, the original description, and the combining author of the combination in the case of a transfer. The type locality is given separately.

The volume embraces 177 genera and 392 species and varieties. Several species are reported for the first time from this coast and the following are newly described: *Ralfsia pacifica* Hollenberg, *Desmarestia linearis* Gardner, *Porphyra Thuretii* Setchell and Dawson and *Herposiphonia pygmaea* Hollenberg. Several new combinations are made in the genera *Acrochaetium* and *Fosliella*. The combination *Acrochaetium Macounii* had, however, been made previously by Hamel (Rev. Alg. 3: 184. 1928).

In his treatment of *Acrochaetium* and *Rhodochorton* the author departs from the generally accepted concept of the limits of these genera. He places in *Acrochaetium* all the species of this complex which form only monosporangia as asexual reproductive organs and in *Rhodochorton* all those bearing tetrasporangia, irrespective of the fact that they may also form monosporangia, as is the case in *Rhodochorton* (*Acrochaetium*) *Daviesii*, and irrespective of the type of chromatophore. Other modern writers who recognize the two genera as distinct refer to *Acrochaetium* all species in which the cells contain from one to a few chromatophores, whether they be stellate, plate-like or band-shaped, and to *Rhodochorton* those species in which the cells contain from a few to many chromatophores. Accordingly *Rhodochorton* never includes species forming monosporangia. The limits between *Acrochaetium* and *Rhodochorton* admittedly are not sharp and a few workers have consequently accepted the conclusions of Drew, who maintains that the two genera should be united under the name *Rhodochorton*. In general, however, the two genera are readily separable on the basis of the type of chromatophore. According to the arrangement of the author there would be ample justification for uniting

them, since *Rhodochorton* would not only be composed of a heterogeneous assortment of species but would even include the type species of *Acrochaetium*, namely, *A. Daviesii*.

In accordance with accepted custom, the author recognizes a family Chantransiaceae, in which he places *Acrochaetium* and *Rhodochorton*. Since the genus *Chantransia* of De Candolle did not include a single species of *Acrochaetium* or of *Rhodochorton*, the family name Chantransiaceae is in contravention of Article 23 of the International Code (1935). The name was recently changed to Acrochaetiaceae by Fritsch (Bot. Rev. 10: 258, note. 1944).

The order Gelidiales is characterized as having cruciately or zonately divided tetrasporangia. However, as now recognized this order includes only genera with cruciately divided sporangia.

The family Nemastomaceae is characterized as having zonately divided tetrasporangia but when Kylin established the family he characterized it as having, as far as known, cruciately divided sporangia, which is true at least of two of the three genera, namely, *Nemastoma* and *Platoma*. Until recently sporangia were not known in the remaining genus, *Schizymenia*. In 1943 Smith and Hollenberg transferred to *Schizymenia* the *Peyssonneliopsis epiphytica* of Setchell and Lawson as well as its so-called host, which Smith and Hollenberg believed to be stages of one and the same plant. This species forms zonately divided tetrasporangia in nemathecia. In the present volume, tetrasporangia are reported for the first time in *Schizymenia pacifica* but no specific statement is made as to their method of division. The sporangia are, however, said to be remote from one another, which is also the condition in *Nemastoma* and *Platoma*. Sporangia are still unknown in the type species of *Schizymenia*, *S. Dubyi*, but their localization in nemathecia in *S. epiphytica* is a condition which is foreign to *Nemastoma* and *Platoma* as well as to *S. pacifica*, which has heretofore been considered a good species of *Schizymenia*. It would seem therefore that the condition in regard to the sporangia of *S. epiphytica* is sufficiently distinct from that in the other members of the Nemastomaceae to justify its exclusion from both *Schizymenia* and the Nemastomaceae.

A genus of particular interest is *Goniotrichopsis*, which was described by the author in 1943. This genus is closely related to *Goniotrichum* but differs from it and all other marine Bangioideae, as far as the reviewer is aware, in one significant feature, namely, the presence in each cell of several disc-shaped chromatophores. This is a condition which should be sought for in other members of the Bangioideae.

Tetrasporangia are reported in *Opuntiella*. This is an important discovery inasmuch as sporangia had thus far not been recorded for this genus.

The comprehensive keys to the genera have passed through

four revisions in the course of Professor Smith's seventeen years' study and teaching at the Hopkins Marine Station. The rigorous tests which they have consequently undergone coupled with the fact that they are based almost exclusively on vegetative characters are good guarantees of their great value.

The illustrations, many of which were prepared by Mrs. Carl F. Janish, rank amongst the best that have been given of the algae. Approximately 80 per cent of the species are illustrated, many of them for the first time. The drawings show the general appearance of the plant but details of structure are also figured if necessary in the identification of genera or species.

Students of marine algae throughout the world will welcome this volume. The work may well serve as a guide in the preparation of future marine floras.—GEORGE F. PAPENFUSS, Department of Botany, University of California, Berkeley.

Illustrated Flora of the Pacific States. Volume two. Buckwheats to Kramerias. By LEROY ABRAMS. Pp. viii + 635, with 1663 figs. Stanford University Press. 1944. \$7.50.

Volume two of this important work embraces those families from Polygonaceae through Krameriaceae. As in volume one the species, with very few exceptions, are illustrated, but unlike the preceding volume the illustrations are aggregated on separate pages, thus reducing costs and greatly enhancing the appearance of the format. The quality of the illustrations is much improved and greater attention has been paid to the depiction of significant details.

The treatment of families follows the author's established policy of segregation; thus we find instead of the single family, Leguminosae, the families Caesalpinaceae, Mimosaceae and Fabaceae. The Rosaceae and Saxifragaceae of other California authors receives similar treatment, a point of view that can be easily and logically defended. Certain inconsistencies in this policy stand out with respect to some of the smaller families. Aizoaceae includes two somewhat discordant elements, the Moluginaceae having hypogynous flowers and a curved embryo much like that found in the Caryophyllaceae, and the Ficoidaceae with its epigynous or perigynous flowers and an embryo that in most cases is bent much like that in many Cactaceae. Cabombaceae with its ranalian type of flower is included with the Nymphaeaceae, a group having many features allying it with the Rhoadales. These are minor problems and the urge to split these families certainly does not have behind it the impelling force of "facility in handling" that one finds in such large families as Leguminosae and Rosaceae.

A similar policy is adhered to in the treatment of genera, for example, it seems good judgment to separate *Grossularia* from *Ribes* and *Fendlerella* from *Whipplea*. The number of "problem

genera" treated in volume two is outstanding. It was no easy task to arrive at decisions in such genera as *Chorizanthe*, *Eriogonum*, *Atriplex*, *Montia*, *Lewisia*, *Silene*, *Ranunculus*, *Delphinium*, almost the entire Cruciferae, *Dudleya*, the *Potentilleae*, *Lupinus*, *Trifolium*, *Astragalus* and *Hosackia*. To be sure, the treatments of some of these genera were contributed by specialists and others followed the works of specialists, but the genetic difficulties inherent in many of them would seem to defy rationalization in the light of the present state of our knowledge about them.

To some, the subspecific categories appearing in the work might seem a bit confusing since both of the terms "subspecies" and "variety" are used. In many genera the category subspecies is used while in others the category variety is used, and in others both categories appear. I suspect that this is not intended to indicate their arrangement in the order outlined for these categories in the International Rules but rather is evidence of the conservative policy of the author in avoiding, in a work of this type, the making of changes and new combinations except where necessitated by a change in status of the entity. The author is to be congratulated for this point of view. When a new combination is unavoidable, the subspecies category is utilized.

Each species is given a common name and in general these are perfectly good English or early Californian vernacular. The tendency among laymen to use the generic name with a vernacular adjective is given recognition with a euphonious and dignified result. This is a subtle way of overcoming the layman's horror of scientific names. It is gratifying to see that where it is necessary or desirable to combine words a hyphen is used in accordance with good grammatical custom.

During the long interval that the volume was in press many entities in the area treated had been described as new and the concepts of others had been revised. These are mentioned, with their bibliographic reference, in the appendix at the end of the volume. Here, a count on the genus *Lupinus* reads like a tally sheet in a three-cornered race between Smith, Heller, and Eastwood. The score to date is Eastwood 45, Smith 22, and Heller 10.

The appearance of volume two further increases the desire to receive volumes three and four and thus bring to completion a work of which we are all justly proud.—HERBERT L. MASON, Department of Botany, University of California, Berkeley.

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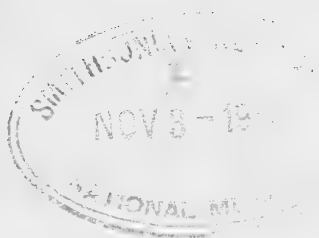


VOLUME VII

NUMBER 8

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SOME NEW LAURENCIAE FROM SOUTHERN CALIFORNIA

ELMER YALE DAWSON

For many years the genus *Laurencia* has been troublesome for collectors of algae along the California coast because of an unwillingness among specialists to tackle the difficulties of the genus and to name the various entities found in the region. Consequently these algae have received only vague designation under names of species mostly of European habitat. In southern California the very distinctive *Laurencia subopposita* has long been the only species clearly understood (3, p. 221, pl. 15, fig. b). The species now known as *L. pacifica* (2, p. 42, fig. 38) was designated under a number of misnomers until very recent years. Of the three species described here, *L. diegoensis* has gone under the name of the more northern *L. spectabilis*. *L. Maxineae* and *L. scrippsensis* seem to be poorly represented in collections, and rarely named at all. The species from the vicinity of La Jolla generally designated as *L. papillosa* is another plant in need of further study. It does not occur, however, during the fall or winter seasons, and an examination of a good series of specimens has not been possible up to the time of this writing.

Acknowledgements are due to Dr. H. L. Mason of the Herbarium of the University of California for the loan of specimens, and to Dr. C. K. Tseng for helpful suggestions during the course of this study.

Laurencia Maxineae is named for my wife who aided in the collection and study of these plants; *L. scrippsensis*, for the Scripps Institution of Oceanography near which the specimens were first discovered; and *L. diegoensis*, for San Diego County, the shores of which it inhabits.

The type specimens are deposited in the Herbarium of the University of California, Berkeley.

***Laurencia Maxineae* sp. nov.** Thalli 3–6 cm. alti, fusco-rubri; surculis erectis compressis, bipinnatis et cum ramis in uno plano orientibus; axibus principibus 1.5 mm. latis, 200–350 μ crassis; cellulis superficialibus cubicis, 20–25 μ diam.; cellulis medularibus 50–60 μ diam., sine tumoribus lenticularibus; ramulis spermatangialibus ovatis, 1 vel 2 cornutis; tetrasporangiis simplicibus, in ramulis ultimis, sine nodosis lateralibus; cystocarpiis ovatis.

Thalli 3–6 cm. tall, reddish-brown, flexible, delicate; erect shoots one to a few from a small attachment to the host, more or less regularly pinnately to bipinnately branched in one plane; terete below, compressed above; main axes 1.5 mm. broad, 200–350 μ thick; surface cells more or less isodiametrical, 20–25 μ diam.; medullary cells 50–60 μ diam., without lenticular thickenings; spermatangial branchlets ovate, solitary on ultimate

branches, commonly with one or two horn-like lateral projecting knobs; tetrasporic stichidia simple, very much like sterile ultimate branchlets, without lateral knobs; cystocarps of variable size and irregular arrangement, ovate, 1 to 3 lateral or terminal on the pinnae (pl. 26, fig. 2; pl. 25, fig. 3; pl. 28, figs. 4, 5).

Type. Epiphytic on *Corallina*, tide pools in the lower littoral, reef near Scripps Pier, La Jolla, California, November 22, 1943, Dawson 43-157 (Herb. Univ. Calif. no. 685719).

The small size, delicate nature and fine-pinnate branching of this species distinguishes it from other *Laurencia* species of the California coast. It is distinguished from *L. splendens* (1, p. 219) by its smaller size and finer and less regular branching. In all proportions it is about one-half the size of *L. splendens*. Reproductive differences cannot be pointed out, since *L. splendens* was described from sterile material.

Laurencia Marineae has been found, other than at the type locality, two miles farther south, on the reef near the "Beach Club," on La Jolla Bay. It grows not only on *Corallina*, but on *Gelidium* and other red algae, on wave dashed littoral rocks at or below mean low tide line. It is not a common plant, but when exactly the right habitat is found in the extreme lower littoral, where rather thick growths of *Corallina* occur, it may be encountered fairly frequently, growing on old plants of that genus.

Laurencia scrippsensis sp. nov. Thalli 10-16 mm. alti, fusco-rubri, caespitosi; surculis compressis, 1.0-1.5 mm. latis, 400-500 μ crassis, pinnatis, cum ramis in uno plano; cellulis superficialibus 20-30 μ diam., cubicis, vallum non formantibus; cellulis medullaribus 70-90 μ diam., sine tumoribus lenticularibus; cystocarpis conspicue tumentibus; tetrasporangiis in pinnatis immutatis paene; ramulis spermatangialibus ovatis.

Thalli epiphytic, 10-16 mm. high, deep reddish-brown, composed of several spreading, or contorted and caespitosely congested shoots arising from the point of attachment to the host, the shoots compressed, 1.0-1.5 mm. broad, 400-500 μ thick, irregularly alternate-pinnately branched in one plane; surface cells more or less isodiametric, 20-30 μ diam., not forming a palisade layer; medullary cells 70-90 μ diam., without lenticular thickenings; cystocarps forming promiscuous bulges on highly irregular branched shoots; tetrasporangial plants more regularly pinnate, less densely branched and with sometimes more strongly, sometimes less strongly compressed shoots; tetrasporangia borne in essentially unmodified pinnae; spermatangial branchlets broadly

EXPLANATION OF THE FIGURES. PLATE 26.

PLATE 26. SOUTHERN CALIFORNIA LAURENCIAE. FIG. 1. *L. diegoensis*: mature spermatangial specimen in first year of development (from type collection), $\times 1$. FIG. 2. *L. Marineae* attached to *Corallina*: a, spermatangial plant; b, tetrasporic plant. (From type collection), $\times 1\frac{1}{2}$. FIG. 3. *L. scrippsensis*: almost mature cystocarpic plant (from type collection), $\times 1\frac{1}{2}$.

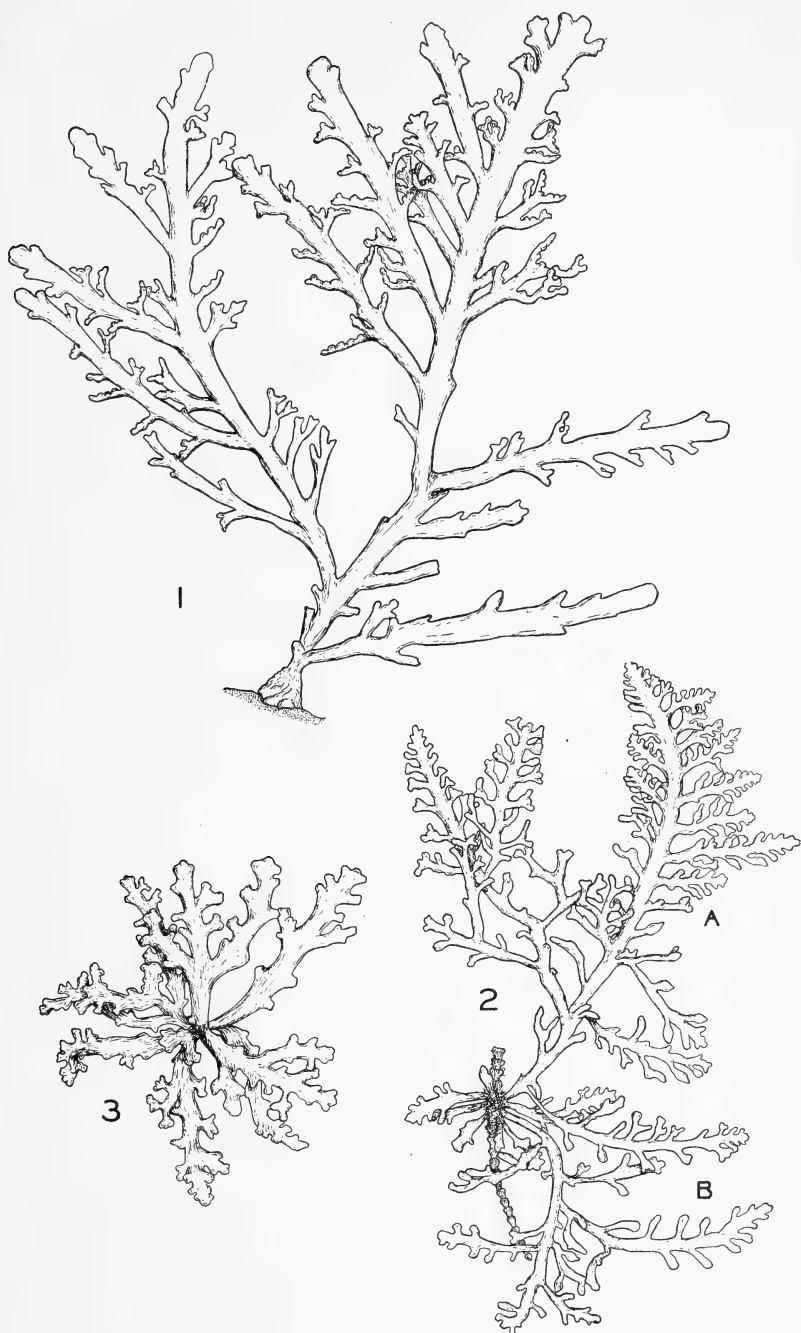


PLATE 26. SOUTHERN CALIFORNIA LAURENCIAE.

ovate to nearly urn-shaped, usually solitary or in pairs in very short pinnae given off from the compressed shoots (pl. 26, fig. 3; pl. 27, figs. 1, 2, 4).

Type. Epiphytic on *Sargassum Agardhianum*, in pools in the lower littoral, on the reef near Scripps Pier, La Jolla, California, November 22, 1943, Dawson 43-158 (Herb. Univ. Calif. no. 685720).

The small size, caespitose growth form and epiphytic habit of this species distinguish it from all other compressed species of *Laurencia* thus far described from the Pacific American coast. It is a very abundant small plant and on some wave-swept rock platforms at La Jolla it grows in dense, fleshy, closely adherent, caespitose clumps, almost covering the underlying host plants. In shaded places or in pools it has a less contorted and a more openly branched habit.

Laurencia diegoensis sp. nov. Thalli 8-20 cm. alti, fusco-rubri; surculis erectis compressis, irregulariter bipinnatis, elongatis cum brevioribus mixtis; ramis in uno plano orientibus; ramis principibus 2-3 mm. latis, 0.5-0.8 mm. crassis; cellulis superficialibus cubicis, 20-30 μ crassis, vallum non formantibus; cellulis medullaribus 80-100 μ crassis, sine tumoribus lenticularibus; ramulis spermatangialibus bulbosis, 1 ad 4 in ramis ultimis brevis; cystocarpiis bulbosis, 2 ad 5 in fasciculis terminalibus; tetrasporangiis compositis, subteretis.

Thalli 8-20 cm. tall, deep reddish-brown; composed of a conic holdfast and erect, strongly compressed shoots; branching irregularly alternate-bipinnate, all in one plane; branches of different orders of irregular length, giving the frond an unsymmetrical appearance; main branches 2-3 mm. broad, 0.5-0.8 mm. thick; surface cells more or less isodiametric, 20-30 μ diam., not forming a palisade layer; medullary cells 80-100 μ diam., without lenticular thickenings; spermatangial branchlets bulbous, borne singly or in groups of 2 to 4 along short ultimate branches; cystocarps bulbous, borne in terminal clusters of 2 to 5 on short ultimate branches; tetrasporangial stichidia compound, the parts rather slender and nearly terete (pl. 26, fig. 1; pl. 28, figs. 1, 2, 3).

Type. On rocks between the 1.0 and 0.0 foot tide levels, reef near Scripps Pier, La Jolla, California, November 22, 1943, Dawson 43-156 (Herb. Univ. Calif. no. 685722).

Other collections seen. CALIFORNIA. Orange County: Balboa, Gardner 2498; Laguna Beach, Fosberg T193, Guernsey LXV. Los Angeles County: Santa Monica, Gardner 2580. San Diego County:

EXPLANATION OF THE FIGURES. PLATE 27.

PLATE 27. SOUTHERN CALIFORNIA LAURENCIAE. FIG. 1. *L. scrippsensis*: portion of a cystocarpic plant, $\times 5$. FIG. 2. *L. scrippsensis*: portion of a tetrasporic plant, $\times 9$. FIG. 3. *L. Mariniae*: portion of a spermatangial plant, $\times 9$. FIG. 4. *L. scrippsensis*: portion of a spermatangial plant, $\times 9$.

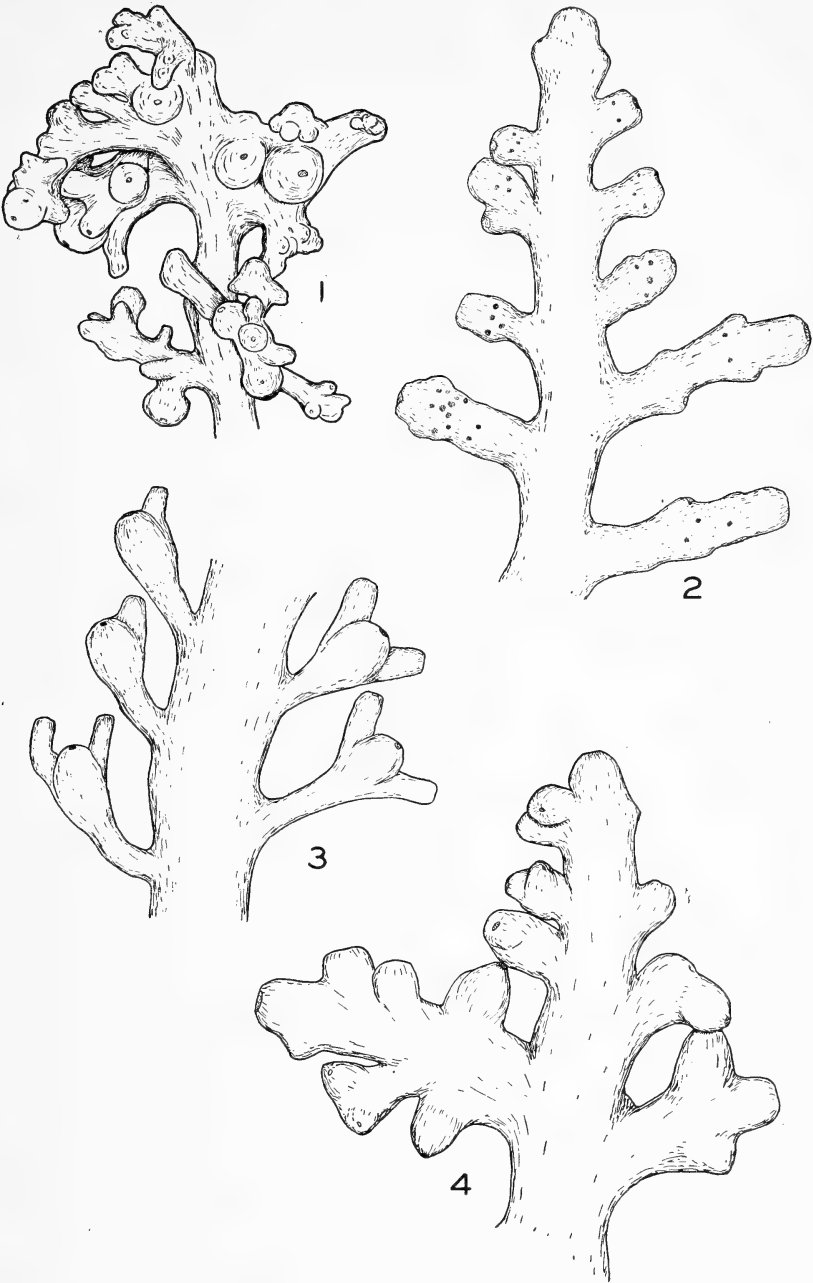


PLATE 27. SOUTHERN CALIFORNIA LAURENCIAE.

vicinity of San Diego, *Wright* (Herb. Univ. Calif. no. 94427); La Jolla, *Snyder* (Herb. Univ. Calif. no 77965), *Dawson* 43-160.

The species is perennial. Figure 1 (pl. 26) is of a small, mature, spermatangial plant in the first year of development.

Many plants in their second year of growth have been found at La Jolla in reproductive state. They are of the same branching proportions as the smaller plants, but are more or less denuded of branches in the lower parts and are encrusted to varying degrees with bryozoans and melobesia.

In looking over a collection of some thirty specimens labeled *Laurencia spectabilis* in the University of California Herbarium, a number of specimens were found to correspond with those collected by the author in the San Diego region. Furthermore, it was found that the specimens could all be separated into two quite distinct morphological groups. These two groups exhibited geographical separation as well. The first group, here considered to be true *L. spectabilis*, is composed of collections ranging from Whidbey Island, Washington, to Santa Barbara, California. The other group, *L. diegoensis*, contains examples from Santa Monica, Balboa, Laguna Beach, La Jolla, and San Diego, California.

The southern plants are all of narrower proportions. Conspicuously broad or expanded main axes are not present in *Laurencia diegoensis*. Most striking, in comparing series, is the prevalence in *L. spectabilis* of regular branching. The branches of the various orders are typically of uniform length, and this is particularly true of the small, ultimate branchlets which are especially uniform, gradually reduced in size toward the growing apices. This uniformity is conspicuously absent in *L. diegoensis* in which the rate of growth of the branchlets is variable and even in the young stages creates an irregular and unsymmetrical branch pattern.

The geographical distribution seems reasonably well defined, with a region between Santa Barbara and Santa Monica marking the southern limit of *L. spectabilis* and the northern limit of *L. diegoensis*. Intensive study of plants growing in this region will undoubtedly bring out details of intergradation and divergence of the two closely related species.

Laurencia diegoensis differs from *L. splendens* (1, p. 219, fig. 24) in being generally a larger plant and in not being epiphytic. It is superficially similar to *L. pinnata* (3, p. 242, pl. 28) but may be distinguished specifically by the tetrasporic stichidia which in *L.*

EXPLANATION OF THE FIGURES. PLATE 28.

PLATE 28. SOUTHERN CALIFORNIA LAURENCIAE. FIG. 1. *L. diegoensis*: portion of a spermatangial plant, $\times 5$. FIG. 2. *L. diegoensis*: portion of a cystocarpic plant, $\times 5$. FIG. 3. *L. diegoensis*: portion of a tetrasporic plant, $\times 5$. FIG. 4. *L. Maxineae*: portion of a tetrasporic plant, $\times 7$. FIG. 5. *L. Maxineae*: portion of a cystocarpic plant, $\times 7$.

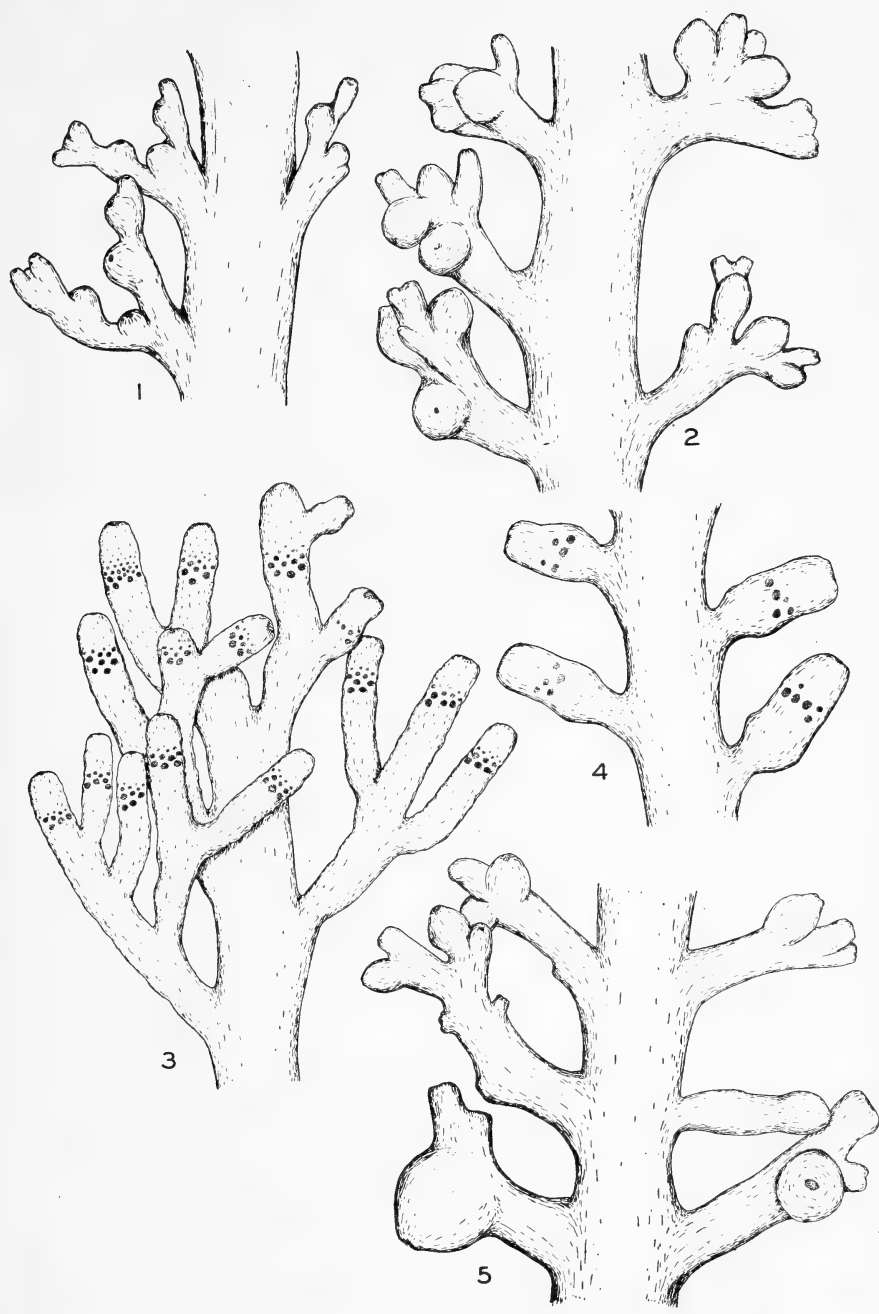


PLATE 28. SOUTHERN CALIFORNIA LAURENCIAE.

pinnata are described as occurring in the "similar ultimate branchlets." In *L. diegoensis* the compound, terete stichidia are quite unlike the vegetative branches. Yamada (3, p. 246) has pointed out the distinctions between *L. spectabilis* and *L. pinnatifida*, particularly the presence of abundant lenticular thickenings in the latter species. He recognized the presence of a broader and a narrower plant under the name *L. spectabilis*, but did not distinguish them specifically.

Scripps Institution of Oceanography,
University of California, La Jolla,
December, 1943.

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NOMINA CONSERVANDA PROPOSALS FOR TEN GENERA OF TREES AND SHRUBS

ELBERT L. LITTLE, JR.

While checking the nomenclature of the forest trees of the United States, I observed that ten generic names of trees and large shrubs now in almost universal use are technically invalid or of questionable validity under the latest International Rules of Botanical Nomenclature (ed. 3, 152 p. 1935. Sixth Internat. Bot. Cong. Amsterdam, Proc. 2 vol. 1935-36). These well-known names are: *Cedrus* Trew, *Abies* Mill., *Coccoloba* P. Br. *ex* L., *Rhacoma* L., *ConDALIA* Cav., *Fremontia* Torr. (1853), *Pilocereus* K. Schumann, *Cephalocereus* Pfeiff., *Bucida* L., and *Halesia* Ellis *ex* L. The nomenclature of each is discussed here, and it is suggested that these names be submitted at the next International Botanical Congress as *nomina generica conservanda proposita*. To reject these names would cause confusion by requiring a few new generic names and more than a hundred specific transfers. All these names have been adopted in my manuscript, "Check List of the Native and Naturalized Trees of the United States," with the exception of the genera *Cedrus* and *Pilocereus*, which were outside the scope of that paper. As it seems likely that most of these names will be conserved later, there will be more stability in nomenclature by using these well-established names.

"Index Londonensis" (6 vols. 1929-31; Suppl. 1941), an index to illustrations of plants, shows that usage is strongly in favor

of all the names proposed for conservation. In fact, some of the rejected names were not even represented in that compilation.

Six of the names listed above are later homonyms (Articles 60 [3] and 61) and four are later synonyms (Article 60). These homonyms became invalid in 1930 when the rule about homonyms was changed to reject a later homonym even if the earlier homonym is a synonym and not in use. The American Code of Nomenclature (Bull. Torrey Bot. Club 34: 167-178. 1907), also in use in the United States for some years earlier, had contained a similar provision. Previous to 1930, the earliest available name was adopted, even if it were a later homonym, provided that the earlier homonym had been rejected as a synonym. Of the names here under discussion the three later homonyms named for persons were given to genera a second time because the earlier names were found to be synonyms.

As Rehder, Weatherby, Mansfeld, and Green (Kew Roy. Bot. Gard. Bull. Misc. Inform. 1935: 341-544. 1935) stated, the homonym rule was changed with the definite understanding that all well-known generic homonyms should, as far as possible, be adopted as *nomina conservanda* under Article 21. These botanists made a systematic search for later homonyms among the seed plants and submitted their list to the Sixth International Botanical Congress at Amsterdam in 1935. The names were divided alphabetically among different persons, but names beginning with the letters D to K were not checked in time to be published. As a result of this and other proposals, additional *nomina conservanda* of seed plants were accepted (Kew Roy. Bot. Gard. Bull. Misc. Inform. 1940: 81-134. 1940). Additional names may be submitted to the Executive Committee at any time, and, if provisionally approved by it, may be retained under authority of the committee pending decision of the next International Botanical Congress (Articles 21 and 22).

Seven of the earlier homonyms and synonyms discussed here were published shortly after 1753 in rare works which did not use binomials. One was published by Miller (Gard. Dict. abridged, ed. 4, 3 vols., illus. 1754). Druce (Bot. Exch. Club Soc. Brit. Isles Suppl. 1913: 426-436. 1914) restored the generic names of that work. Two were published by Duhamel (Traite Arbr. Arbust., 2 vols., illus. 1755). Nieuwland (Am. Midland Nat. 1: 16. 1909) called attention to the genera of that reference. Another name mentioned here was published by Trew (Herb. Blackw., Cent. 2, illus. 1754), a work revived also by Nieuwland (Am. Midland Nat. 1: 221-224. 1910). Three were in the well-known work by Patrick Browne (Civ. Nat. Hist. Jamaica, 503 pp., illus. 1756).

Genera in these books are accepted by most modern authors, though Article 67 (3) and Example (2) raise some questions

about names of this kind. It would have been simpler in the beginning to have rejected all works not adopting binomial nomenclature, as in an American Code rule. Genera appearing in these works were without species and thus had no species from which a type could be selected. Some of the names were genera of pre-Linnaean authors that were accepted by later workers anyway. However, a few of these rare books contain different generic names that technically invalidate the later homonyms and synonyms now in use, though most of these names have been detected. Proposals to reject generic names published in works after 1753 not adopting binomial nomenclature were defeated by large majorities at the Congresses in 1905 and 1930. It is not likely that a similar amendment would be accepted now. Wilmott (Kew Roy. Gard. Bull. Misc. Inform. 1935: 66, 90–92. 1935; Sprague, Synop. Prop. Nomencl. Sixth Internat. Bot. Cong. 15, 77–78. 1935; Sprague, Prel. Opin. Nomencl. Prop. Sixth Internat. Bot. Cong. 508. 1935), proposed that a list of works of this kind contrary to the rules be regarded as not validly published. His list included the books of Miller and Browne mentioned below but not some other rare works cited here. If the rule applied only to a definite list of books, there would still be a few other, rarer books, such as those cited in this paper, containing unrecorded names. A partial list of these works might cause more confusion than no list at all. Wilmott's proposal was referred to a special committee to report on the effects of its adoption (Sixth Internat. Cong. Bot. Amsterdam, Proc. 1: 338–341. 1936). However, as most of these early generic names have been accepted or rejected in favor of *nomina conservanda*, there would be less confusion now to retain all. Wilmott's proposal would require many changes in the *nomina conservanda* and create more complications in nomenclature. Very few additional early published names probably remain undetected; as the number of rare books has a limit. When earlier names are discovered, the later names affected can be conserved.

When the names of Cactaceae were being checked, it was discovered that present usage of *Cephalocereus* Pfeiff. and *Pilocereus* Pfeiff. is contrary to Articles 51 and 16. Both names as well as the earlier name *Cephalophorus* Lem., are all based upon the same type species, *Cactus senilis* Haworth, and therefore, are synonyms. A search of the literature revealed that Britton and Rose (Contr. U. S. Nat. Herb. 12: 415. 1909; Cactaceae 2: 25. 1920) had observed this fact and that Werdermann (Beiträge zur Nomenklatur. 11. *Cephalocereus* Pfeiff. und *Pilocereus* K. Sch. [nicht Lem!]; Kakteenkunde 1937: 129–130, illus. 1937) had proposed that *Cephalocereus* and *Pilocereus* be made *nomina conservanda*. It seems desirable to summarize here the nomenclature of these genera and to confirm Werdermann's proposal.

There is some question whether it is necessary to conserve *Abies* Mil. and *Cephalocereus* Pfeiff. in order to retain them as valid names. Whether to conserve *Fremontia* Torr. (1853) or accept *Fremontodendron* Cov. instead is a controversial matter, because both names are in use. The other seven names clearly are illegitimate and must either be abandoned or conserved.

The policy of conserving names of small genera is subject to deliberation. These invalid names have not more than five recognized species: *Cedrus* Trew, *Fremontia* Torr. (1853), *Bucida* L., and *Halesia* Ellis. It sometimes is simpler to change a name than to make an exception in the rules, though names of a few monotypic genera have been conserved. However, if there is greater stability in nomenclature by retaining the name of a small but well known genus, the name should be conserved.

Another name in use, *Hopea* Roxb. (Pl. Coast Corom. 3: 7, pl. 210. 1819), family Dipterocarpaceae, is invalidated by an earlier homonym originally applied to a tree species of the United States. *Hopea* Garden ex L. (Mant. Pl. 1: 14. 1767) was published with one species, *Hopea tinctoria* Garden ex L. This genus was combined in 1791 with *Symplocos* Jacq. (Enum. Pl. Ins. Carib. 5. 1760), and the United States species is *Symplocos tinctoria* (Garden) L'Hérit. *Hopea* Roxb. is in use for a genus of about fifty species in the East Indies, Philippine Islands, and India. This name, which is outside the scope of my study, probably will be considered at the next Congress with the other homonyms from the letters D to K.

The ten generic names herein proposed as *nomina conservanda* are discussed according to the sequence and numbers of Dalla Torre and Harms (Gen. Siphon. 921 pp. Lipsiae. 1900-07).

23. (Pinaceae.) *Cedrus* Trew, Cedr. Lib. Hist. 6., illus. 1757. Not *Cedrus* Duhamel, Traité Arbr. Arbust. 1: 139, pl. 52 and fig. 1755. Not *Cedrus* Mill., Gard. Dict. ed. 7. 1759. Type species: *Cedrus libani* Barre. ex Loud., Hort. Brit. 388. 1830.

Nomina rejicienda: none?

Cedrus Trew is a well-known genus of four species of Northern Africa, Cyprus, Asia Minor, and Asia. The name is accepted unanimously and, of course, was adopted by Bentham and Hooker, Index Kewensis, Engler and Prantl, and Dalla Torre and Harms.

Just as there has been confusion in the application of the common name "cedar" to more than one genus, the ancient Greek name κέδρος was used for different genera by early botanists. The earliest use of *Cedrus* after 1753 was by Duhamel (1755), who followed Tournefort (Elem. Bot. 1: 461, pl. 361. 1694) and even copied the latter's drawings in applying the name to species now in *Juniperus* L. (1753). Duhamel (p. xxviii) divided *Juniperus* L. into three genera, *Juniperus*, *Cedrus*, and *Sabina*, but did not use binomials. *Sabina* had been published the preceding

year by Miller (Gard. Dict. abridged, ed. 4, vol. 3. 1754). Trew apparently was the first after Linnaeus to use *Cedrus* in its present sense for the cedar of Lebanon, though he did not make a proper binomial. *Cedrus* Mill. is a synonym of *Cedrela* P. Br. (Civ. Nat. Hist. Jamaica 158, pl. 10, fig. 1. 1756), family Meliaceae. Miller's name was based on a different use of the name *Cedrus* by Plukenet (Almag. Bot. Phyt. 92, pl. 157, fig. 1. 1696) and was adopted in the second edition of his Gardeners Dictionary (1733).

Cedrus Trew is so well established for the cedar of Lebanon and related species that apparently no direct synonyms have been made. It seems better to make this name a *nomen conservandum* than to erect a new generic name, even for only four species.

29. (Pinaceae.) *Abies* Mill., Gard. Dict. abridged, ed. 4, vol. 1. 1754. Not *Abies* Trew, Herb. Blackw., Cent. 2, pl. 198. 1754. Type species: *Abies alba* Mill., Gard. Dict. ed. 8, *Abies* no. 1. 1768.

Nomina rejicienda: none?

Abies Mill. contains about forty species of trees, known as firs, in north temperate regions. The name is in universal usage and was accepted by Bentham and Hooker, Index Kewensis, Engler and Prantl, and Dalla Torre and Harms. *Abies* Trew was published with colored plate for a species of spruce, now included under *Picea Abies* (L.) Karst.

Tournefort (Inst. Rei Herb. 1: 585, pl. 353-354. 1700) used *Abies* in the modern sense, but the two ancient Latin names *Abies* and *Picea* have been interchanged at times in the past. For example, Loudon (Arb. Frut. Brit. 4: 2293, 2329. 1838) used *Picea* for the firs and *Abies* for the spruces. However, for many years the present and opposite interpretation has been universal. Apparently there are no direct synonyms. Both *Abies* Mill. and *Abies* Trew were published in works that did not adopt binomial nomenclature. It is uncertain which name appeared first in 1754. If Miller's name was earlier, then it has priority and does not need to be conserved (Article 16). However, because of the uncertainty, it seems best to conserve *Abies* Mill.

Nieuwland (Am. Midland Nat. 1: 221-224. 1910) not only cited *Abies* Trew (1754) but another publication of *Abies* in 1754 in a rare work said to have been by Dom. Robbe and not available to me. He cited this list of plants as follows: "(Dom. Robbe.) Catalogue des plantes usuelles avec une explication des principaux termes de botanique, pour servir d'introduction aux démonstrations commencées dans le jardin de botanique le 27 Juin 1754, sous les auspices de Mgr. le Duc de Chaulnes, etc. A Amiens. 1754." I do not know whether *Abies* in this publication is the same as *Abies* Mill. or *Abies* Trew.

2209. (Polygonaceae.) *Coccoloba* P. Br. ex L., Syst. Nat. ed. 10, 2: 1007, 1367. 1759. Type species: *Coccoloba uvifera* (L.) L., Syst. Nat. ed. 10, 2: 1007. 1759.

Nomina rejicienda: *Guaiabara* Mill., Gard. Dict. abridged, ed. 4, vol. 2. 1754. *Coccolobis* P. Br., Civ. Nat. Hist. Jamaica 209, pl. 14, fig. 3. 1756. *Naucorephes* Raf., Fl. Tellur. 2: 34. 1845. *Schlosseria* Mill. ex Steudel, Nom. Bot. ed. 2, 2: 531. 1841. *Lyperodendron* Willd. ex Meissn. in DC., Prodr. 14: 168. 1857; as synonym. *Uvifera* (L.) Ktze., Rev. Gen. 2: 561. 1891.

Coccoloba P. Br. ex L. is a large genus of about 130 species of shrubs and trees in the American tropics. This name is in almost universal usage and was accepted by Bentham and Hooker, Index Kewensis, Engler and Prantl, and Dalla Torre and Harms. The later synonyms are not in use.

Guaiabara Mill., a pre-Linnaean genus of Plumier, was proposed in a work without binomial nomenclature. Druce (Bot. Exch. Club Soc. Brit. Isles Suppl. 1913: 405-440. 1914), in calling attention to the genera published in this edition, listed *Guaiabara* (Plum.) Mill. as a synonym of *Coccoloba* L. but made no reference to the later publication of the latter name, which was published in 1759, not 1753. *Guaiabara* was taken up by Boehm. (in Ludw., Def. Gen. Pl. 402. 1760). A variant spelling was *Guiabara* Adans. (Fam. Pl. 2: 277. 1763). Miller's name was adopted in 1922 by House (Am. Midland Nat. 8: 64. 1922), who made three transfers to this genus under the spelling *Guajabara*.

Kuntze (Hort. Cliffs 487. 1738), regarding 1735 as the starting date, adopted the earlier Linnean name, *Uvifera* L.

Several recent authors, such as Small (Fl. Southeast. U. S. 383. 1903; Man. Southeast. Fl. 461. 1933) have taken up the older name and spelling, *Coccolobis* P. Br. Sandwith (Jour. Bot. 78: 99. 1940) held that the two spellings were different names (Article 70). He wrote: "In conclusion, it may be pointed out, with regret, that *Coccolobis* P. Br., according to two good nomenclatural authorities, not merely antedates *Coccoloba* L. but must actually be treated as a different name. The two names are not orthographic variants, since *Coccolobis* has the termination of a diminutive, and *Coccoloba* is thus an illegitimate substitution. We are, therefore, faced with a very large number of necessary transfers from *Coccoloba* to *Coccolobis*, unless it is decided to conserve *Coccoloba*. The discovery of the earliest publication of some of these will not be an easy task, since the 'Index Kewensis' formerly treated the two names as orthographic variants, and so have the American writers (e.g., Britton, Small), who have correctly adopted *Coccolobis*, attributing the binomial to the original author of the species under *Coccoloba*. Even apart from such unintentional new combinations, considerably more than a hundred others will have to be made." He even made (p. 100) the new combination *Coccolobis gymnorhachis* (Sandwith) Sandwith, based upon *Coccoloba gymnorhachis* Sandwith.

Linnaeus (Syst. Nat. 2: 1367. 1759) did not intend to make a

new name when he cited Browne as author of the generic name; he omitted Browne's different spelling.

As *Coccoloba* P. Br. *ex* L. is used by most authors instead of *Coccolobis* P. Br. and as there is some question as to whether the two are different names or orthographic variants, it seems best to conserve the later and best known spelling, *Coccoloba* P. Br. *ex* L. Then any new combinations some authors might make would be avoided. With either spelling, P. Browne should be cited as author.

4648a. (Celastraceae.) *Rhacoma* L., Syst. Nat. ed. 10, 2: 896, 1114. 1759. Not *Rhacoma* Adans., Fam. Pl. 2: 117. 1763. Type species: *Rhacoma crossopetalum* L., Syst. Nat. ed. 10, 2: 896. 1759.

Nomina rejicienda: *Crossopetalum* P. Br., Civ. Nat. Hist. Jamaica 145, pl. 16, fig. 1. 1756.

Rhacoma L. contains ten to fifteen species of shrubs and small trees in tropical America. This name was accepted by Engler and Prantl and by Dalla Torre and Harms (Supplementum) and is well established in use. Some authors include in it the related smaller genera *Myginda* Jacq. (Enum. Pl. Carib. 1. 1760) and *Gyminda* (Griseb.) Sarg. (Gard. and Forest 4: 4. 1891). In Index Kewensis *Rhacoma* L. was placed as a synonym of *Myginda* Jacq., published a year afterwards.

The later homonym *Rhacoma* Adans. is a synonym of a section of *Centaurea* L. (Sp. Pl. 909. 1753; Gen. Pl. ed. 5, 389. 1754), family Compositae, and has not been used by recent authors.

Crossopetalum P. Br. was originally described with a single species in a work without binomial nomenclature. *Rhacoma crossopetalum*, published as a single species of a new genus, was based upon *Crossopetalum* P. Br., which was cited as a synonym and from which the specific name was taken. Thus, *Rhacoma* L. was a deliberate change of name and illegitimate under Articles 16 and 60 (1). The genus *Crossopetalum* P. Br. was restored by O. Kuntze (Rev. Gen. Pl. 1: 117. 1891) to include both *Rhacoma* L. and *Myginda* Jacq. Very few others accepted Browne's name. Among these were Hitchcock (Mo. Bot. Gard. Ann. Repts. 4: 70. 1893) and Small (Fl. Southeast. U. S. 735-736. 1903). The names *Crossopetalon* Adans. (Fam. Pl. 2: 224. 1763) and *Crossopetalum* Roth (Enum. Pl. Phaner. Germ. 1 [1]: 515. 1827) were given afterwards to a genus, now section *Crossopetalum* DC. of *Gentiana* L. As *Crossopetalum* P. Br. has not been adopted by later authors, the name established in use, *Rhacoma* L. should be retained as a *nomen conservandum*.

4862. (Rhamnaceae.) *Condalia* Cav., Anal. Cienc. Nat. (Madrid) 1: 39, pl. 4. 1799. Not *Condalia* Ruiz and Pavon, Fl. Peruv. Chil. Prodr. 11, pl. 2. 1794. Type species: *Condalia microphylla* Cav., Anal. Cienc. Nat. (Madrid) 1: 40, pl. 4. 1799.

Nomina rejicienda: none?

The genus *Condalia* Cav. contains about ten species of shrubs and small trees distributed from Southwestern United States and Mexico to South America. The name is in unanimous usage and apparently has no synonyms but is a later homonym of *Condalia* Ruiz and Pavon. *Condalia* Cav. was accepted by Bentham and Hooker, Index Kewensis, by Engler and Prantl, and by Dalla Torre and Harms.

Condalia Ruiz and Pav. is a synonym of *Coccocipsilum* P. Br. (Civ. Nat. Hist. Jamaica 144, pl. 6, fig. 2. 1756) family Rubiaceae, and was already suppressed when the name was given to a second genus. Cavanilles explained the synonymy and dedicated a new genus to the memory of Antonio Condál. If *Condalia* Cav. is not conserved, then a new generic name with specific transfers would be necessary.

5046. (Sterculiaceae.) *Fremontia* Torr., Smithson. Inst. Contr. Knowl. 5 (1) [6 (2)] (Pl. Frémont.): 5, pl. 2. 1853. Also in Am. Assoc. Adv. Sci. Proc. 4: 191. 1851; *nomen subnudum*. Not *Fremontia* Torr. in Frém. Rept. Explor. betw. Mo. River and Rocky Mts. 91. 1843. Type species: *Fremontia californica* Torr., Smithson. Inst. Contr. Knowl. 5 (1) [6 (2)] (Pl. Frémont.): 5, pl. 2. 1853.

Nomen rejiciendum: Fremontodendron Cov., Contr. U. S. Nat. Herb. (Botany Death Valley Exped.) 4: 74. 1893.

Fremontia Torr. (1853) is a small genus of shrubs or small trees restricted to California, Arizona, and Lower California. The number of species of these variable plants is interpreted by different authors as one, two, or five, and there is a fossil species, *Fremontia lobata* Axelrod (Carnegie Inst. Wash. Publ. 516: 123, pl. 11, figs. 8, 10. 1939; Miocene, California).

Fremontia Torr. (1843), family Chenopodiaceae, had only one species. The name was suppressed five years later by Torrey himself (in Emory, Notes Mil. Recon. Ft. Leavenworth, Calif. 149. 1848) when he learned that it was the same as *Sarcobatus* Nees, published for the same species shortly before Torrey's name in a rare and costly work not known in the United States until several years later. As he was required to take up Nees's earlier name, Torrey (Am. Assoc. Adv. Sci. Proc. 4: 191. 1851) used the name *Fremontia* for another genus.

The name *Fremontia* Torr. (1853) was accepted for the genus of Sterculiaceae by Bentham and Hooker, Index Kewensis, Engler and Prantl, and Dalla Torre and Harms. It has been adopted also in nearly all the floras and manuals covering its area, including: Jepson, Man. Fl. Pl. Calif. 636. 1925; Sargent, Man. Trees No. Am. ed. 2, 749. 1922; Sudworth, U. S. Dept. Agr. Misc. Circ. 92 (Check List Forest Trees U. S.): 206. 1927; Munz, Man.

Southern Calif. Bot. 311. 1935; McMinn and Maino, Illus. Man. Pac. Coast Trees 291. 1935; Jepson, Fl. Calif. 2: 506. 1936; Van Dersal, U. S. Dept. Agr. Misc. Publ. 303 (Native Woody Plants of U. S.): 133. 1938; McMinn, Illus. Man. Calif. Shrubs 352-356, illus. 1939; Tidestrom and Kittell, Fl. Ariz. and New Mex. 124. 1941, and Harvey, Madroño 7 (A Revision of the Genus *Fremontia*): 100-110. 1943.

Fremontodendron Cov. was used in the following publications: Sudworth, U. S. Dept. Agr. Div. Forestry Bull. 14 (Nomenclature of the Arborescent Flora of U. S.): 272. 1897; Sudworth, U. S. Dept. Agr. Div. Forestry Bull. 17 (Check List Forest Trees U. S.): 86. 1898; Sargent, Silva No. Am. 14: 97. 1902 (in list of corrections, though *Fremontia* had been used in the text, vol. 1: 47, pl. 23. 1892); Sargent, Man. Trees No. Am. 676. 1905; Eastwood, Calif. Acad. Sci. Occas. Papers 9 (Handbook of Trees of Calif.): 69, pl. 48. 1905; Britton and Shafer, No. Am. Trees, 695. 1907; Sudworth, Forest Trees Pac. Slope 382. 1908; Dayton, U. S. Dept. Agr. Misc. Publ. 101 (Important Western Browse Plants): 115. 1931; and Kearney and Peebles, U. S. Dept. Agr. Misc. Publ. 423 (Flowering Plants and Ferns of Ariz.): 380. 1942.

Index Londonensis cites for the type species twenty-four illustrations under *Fremontia* and only four under *Fremontodendron*.

Only one species was known in this genus until 1918, when *Fremontodendron mexicanum* Davidson was published under the second generic name. Three additional species were described under *Fremontia* by Eastwood in 1934.

Harvey (Madroño 7: 100-110, illus. 1943) has accepted the name *Fremontia* for this genus in her recent taxonomic revision. She noted that this name was a later homonym and technically still under consideration by the special committee appointed by the Amsterdam Congress. Later homonyms were taken up alphabetically but a few letters, including F, were not finished in time for the Congress. As *Fremontia* is the name now used by a majority of taxonomists of Western United States, she preferred to await the results of the committee before making further nomenclatural changes.

The case for conserving *Fremontia* Torr. (1853) is not as strong as that for most of the names presented here, as the name is not in universal use and as the genus is a small one. However, it should be borne in mind that Torrey's procedure of honoring Frémont with a second genus when the first one was found invalid was in keeping with the customs of the times and correct under the rules until 1930. As it was the intention under the rules to conserve the later homonyms invalidated in 1930 and as this name was not considered at the 1935 Congress, *Fremontia* doubtless will be presented at the next one.

5402. (Cactaceae.) *Pilocereus* K. Schumann¹ in Engler and Prantl, Natürl. Pflanzenfam. 3 (6a): 179. 1894. Not *Pilocereus* Lem., Cact. Gen. Nov. Sp. Hort. Monvill. 6. 1839. Type species: *Pilocereus leucocephalus* Poselger, Allg. Gartenz. 21: 126. 1853.

Nomina rejicienda: none?

Pilocereus K. Schumann contains about forty species from Florida and Southwestern United States south to South America. This name was accepted with authorship attributed to Lemaire by K. Schumann in Engler and Prantl and by Dalla Torre and Harms.

Pilocereus Lem. was originally published as a new genus and segregate from *Cereus* Mill. with two species transferred from *Cereus*. *Pilocereus senilis* was described at length and *P. columna* mentioned. As so defined, *Pilocereus* Lem. is a direct synonym of *Cephalophorus* Lem. (Cact. Aliq. Nov. Hort. Monvill. p. xii. 1838; before May 5) and *Cephalocereus* Pfeiff., Allg. Gartenz. 6: 142. 1838 (May 5). All three names are based upon the same type species, *Cereus senilis* Haworth, and are synonyms (Article 51). As the third in this series of names, *Pilocereus* Lem. must be rejected (Article 16).

Some authors, such as Britton and Rose (Cactaceae 2: 25. 1920), regarded *Pilocereus* Lem. as a synonym of *Cephalocereus* Pfeiff. in accordance with the rules. Berger (Mo. Bot. Gard. Ann. Repts. 16: 69. 1905) applied the name as a subgenus, *Cereus* subg. *Pilocereus* Berger, and stated: "The name *Pilocereus* was originally employed for *Cephalocereus*. These were separated by Schumann, whilst *Pilocereus* was made the recipient of any strange-looking *Cereus*, especially those with hairy areoles. By degrees *Pilocereus* has become a very heterogeneous and senseless genus."

Thus, *Pilocereus* is now established in a different sense from that of Lemaire. It seems simplest to conserve the genus as emended by K. Schumann, as suggested by Werdermann (Kakteenkunde 1937: 130. 1937) or as emended by a later author, rather than to erect a new genus and make many transfers to it. If *Pilocereus* as a conserved genus is reunited with *Cephalocereus*, then the latter name still is used (Article 21, Note 3, and Article 56).

5403. (Cactaceae.) *Cephalocereus* Pfeiff., Allg. Gartenz. 6: 142. 1838 (May 5). Type species: *Cephalocereus senilis* (Haw.) Pfeiff.

Nomina rejicienda: *Cephalophorus* Lem., Cact. Aliq. Nov. Hort. Monvill. p. xii. 1838 (before May 5). Not *Cephalophora* Cav.,

¹ Werdermann's proposal to conserve *Pilocereus* and *Cephalocereus* has recently been discussed by Leon Croizat (Notes on *Pilocereus*, *Monvillea* and *Malacarpus* with special reference to Colombian and Venezuelan species. *Caldasia* 8: 251-260. 1943). He stated that the proper reference to *Pilocereus* Lem. *nom. conserv.* was not to Schumann in Engler and Prantl but to Lemaire's subdivision "C" in Rev. Hort. 1862: 426-430. 1862.

Icon. Descr. Pl. Hisp. 6: 79, pl. 599. 1801. *Pilocereus* Lem., Cact. Gen. Nov. Sp. Hort. Monvill. 6. 1839.

Cephalocereus Pfeiff., as interpreted at present, contains about eight species of Mexico, Bolivia, and Brazil. This generic name was accepted by Engler and Prantl and by Dalla Torre and Harms. Some authors, such as Britton and Rose (Cactaceae 2: 25. 1920), include in *Cephalocereus* the larger, segregate, and emended genus *Pilocereus* discussed above.

Under the International Rules (Article 70) *Cephalophorus* Lem. probably is considered a distinct name from *Cephalophora* Cav. and not an orthographic variant, or homonym, of the latter. Pfeiffer promptly erected the new name *Cephalocereus* because he regarded *Cephalophorus* Lem. as invalidated by the earlier *Cephalophora* Cav. As Pfeiffer's name has become established and *Cephalophorus* Lem. is not used at present, the question can be settled definitely merely by making *Cephalocereus* Pfeiff. a *nomen conservandum*, as Werdermann (Kakteenkunde 1937: 130. 1937) suggested.

5543. (Combretaceae.) *Bucida* L., Syst. Nat. ed. 10, 2: 1025, 1368. 1759. Type species: *Bucida Buceras* L., Syst. Nat. ed. 10, 2: 1025. 1759.

Nomen rejiciendum: *Buceras* P. Br., Civ. Nat. Hist. Jamaica 221, pl. 23, fig. 1. 1756.

This genus of about five species of the West Indies, Mexico, and Central America, is universally known as *Bucida* L. The name was accepted by Bentham and Hooker, Engler and Prantl, and Dalla Torre and Harms, but in Index Kewensis as a synonym of the later name *Terminalia* L. (Mant. Pl. 1: 27. 1767). The specific name of the type species was the same as Patrick Browne's generic name, which Linnaeus cited as a synonym. Thus, *Bucida* L. definitely is illegitimate under the present rules, Articles 16 and 60 (1), as an intentional change of name.

Buceras P. Br. was originally described with a single species in a work without binomials. The name "*Bucida Buceras*" appeared without description as a label of the figure and would not be a valid binomial (Article 68 [4]). *Buceras* P. Br. was restored by Hitchcock (Mo. Bot. Gard. Ann. Repts. 4: 85. 1893), but the name was not accepted widely. The later homonym *Buceras* Hall. ex All. (Fl. Pedem. 1: 313. 1785) is a synonym of *Trigonella* L. (Sp. Pl. 776. 1753; Gen. Pl. ed. 5, 338. 1754), family Leguminosae.

6410. (Styracaceae.) *Halesia* Ellis ex L., Syst. Nat. ed. 10, 2: 1044, 1369. 1759. Not *Halesia* P. Br., Civ. Nat. Hist. Jamaica 205, pl. 20, fig. 1. 1756. Not *Halesia* Loefl., Iter Hisp. 188. 1758; as synonym? Type species: *H. carolina* Ellis ex L., Syst. Nat. ed. 10, 2: 1044. 1759.

Nomina rejicienda: Hillia Boem. in Ludwig, Def. Gen. Pl. 71. 1760. Not *Hillia* Jacq., Enum. Pl. Carib. 3. 1760. ? *Halia* St. Lag., Ann. Soc. Bot. de Lyon 8: 175. 1881; *nomen nudum*. *Mohria* Britton, Gard. and Forest 6: 434. 1893 (Oct. 18). Not *Mohria* Sw., Synops. Fil. 159. 1806. *Carlomohria* Greene, Erythea 1: 236. 1893 (Nov. 3). Also Erythea 1: 246. 1893 (Dec. 1). *Mohrodendron* Britton, Gard. and Forest 6: 463. 1893 (Nov. 8).

Halesia Ellis, a genus of about three or four species in Eastern United States and one in Eastern China, is a later homonym of *Halesia* P. Br. In his first letter to Linnaeus in 1756 or 1757, John Ellis (in Smith, James Edward. Select. Corr. Linn. 1: 82. 1821) submitted the plant with the request that it be named *Halesia*, for Stephen Hales, because *Halesia* P. Br. was a synonym. This wish Linnaeus granted, as indicated in his letter to Ellis on May 30, 1759 (in Smith, James Edward. Select. Corr. Linn. 1: 124. 1821). *Halesia* Ellis was accepted by Bentham and Hooker, Index Kewensis, Engler and Prantl, Dalla Torre and Harms, Perkins (Pflanzenreich 30 [IV. 241]: 94. 1907), and modern authors.

Halesia P. Br., a later synonym of *Guettarda* L., (Sp. Pl. 991. 1753; L., Gen. Pl. ed. 5, 428. 1754), family Rubiaceae, was published in a work which did not use binomial nomenclature. Apparently no binomials were made in *Halesia* P. Br. or *Halesia* Loebl., and these names were not adopted by later authors. Obviously there can be no confusion in rejecting two earlier homonyms nearly two hundred years old and in which no specific names were made.

Hillia Ludw. was proposed as a new name for *Halesia* Ellis because of the earlier *Halesia* P. Br. However, *Hillia* Jacq., an accepted genus of Rubiaceae with a few species, appearing in the same year, 1760, may have priority.

Except for a period of about twenty years after 1893, when *Mohrodendron* Britton was also in use, *Halesia* Ellis ex L. has been in universal usage. Certain American taxonomists following the American Code rejected it, because of the earlier homonym but later restored it because *Halesia* P. Br. was published without a type species and invalid under their rules. *Halesia* Ellis ex L. was correct under International Rules also until 1930, when Article 61, making later homonyms illegitimate, was adopted. Apparently the oldest available name for this genus is *Carlomohria* Greene, which was not in usage by other authors after its publication. This name has priority of five days over *Mohrodendron* Britton. *Halesia* Ellis ex L., like *Fremontia* Torr. (1753), was in the group of homonyms from D to K not considered at the 1935 Congress and subject to later action.

United States Forest Service,
Department of Agriculture, Washington, D. C.,
December, 1943.

FORESTIERA IN SOUTHERN AND SOUTHWESTERN TEXAS

V. L. CORY

Material of *Forestiera* growing along the delta of the Rio Grande in Texas has long been accepted by botanists as *F. angustifolia* Torr., a species which, in Texas, occurs only much farther west,—particularly in the trans-Pecos area of the state. My tentative identification of this Rio Grande material as *F. porulosa* was questioned by Mr. Ernest J. Palmer who had referred it to *F. angustifolia*. During subsequent correspondence between us it was agreed that we were both wrong in our tentative identifications, and that the species was undescribed.

Forestiera texana sp. nov. Arbor 2.5–4 m. altus, glaber, cortice griseo, ramulis gracilibus, haud rigidis; foliis saepissime oppositis, fasciculatis, paribus raro vel 2-paribus, oblongis, elliptico-oblongis ad ellipticis, apicibus rotundatis, cuneatis vel basibus rotundatis, brevipetiolatis subsessilibusve, ad 5 cm. longis, 9 mm. latis, saepissime 2.5 cm. longis vel minoribus, 6 mm. latis vel arctioribus, auctumno multo longioribus latioribusque quam vere, lamina subtus porulosa manifeste 1-nervia, utrinque pallide viride; pedicellis plerumque 4–5 mm. longis; fructo oblongo, saepius recurvo, acutato, stylo gracili terminato, 1 mm. longo vel brevior; nucula oblonga pluricostulata, basi truncata, saepius curva, apice acutata, ad 8 mm. longa, 2.5 mm. crassa.

Small tree 2.5–4 m. high, glabrous, with grayish bark and slender not stiff, branchlets; leaves chiefly opposite, scarcely fasciculate, occurring in pairs or infrequently with the pairs doubled, oblong, elliptic-oblong to elliptic, rounded at the apices; cuneate to rounded at bases, short-petioled to subsessile, up to 5 cm. long and 9 mm. broad, but mostly 2.5 cm. long or less and 6 mm. or less broad, being both much longer and much broader late in the season than in early spring, the under surface porulose and conspicuously 1-nerved, both surfaces light green; pedicels mostly 4–5 mm. long; fruit oblong, usually curved, acute, tipped with a slender style which is 1 mm. long or somewhat more; nutlet oblong, many-ribbed, truncate at the base, usually curved, acute at the apex, up to 8 mm. long and 2.5 mm. broad.

Type. Nine miles south southeast of La Feria, Cameron County, Texas, April 4, 1938, *Cory 28393* (Arnold Arboretum, Harvard University; isotype, Tracy Herbarium of A. and M. College of Texas, College Station).

Other specimens seen. Texas: Brownsville, Cameron County, April 4, 1938, *Cory 28293*; southwest of Donna, Hidalgo County, November 13, 1940, *Cory 36273*; La Joya, Hidalgo County, August 24, 1943, Mrs. E. J. Walker (*Cory 43015*).

All of these specimens have been studied carefully and com-

pared with typical *F. angustifolia* collected at the San Felipe Country Club of Del Rio, Val Verde County, Texas, in May, 1943 (*Cory 41729*). The writer has seen *F. texana* growing only in Cameron and Hidalgo counties, both localities being rather remote from the range of *F. angustifolia*. Certain contrasting characters of these two species are given in the following table:

	<i>F. texana</i>	<i>F. angustifolia</i>
Habit	Moderately branched small tree	Densely branched bush or shrub
Bark	Grayish or pale	Dark to almost black
Branchlets	Elongate, slender, not stiff	Short, stout, stiff
Foliage	Pale green	Dark green
Leaves	Averaging about 20×4 mm., comparatively broad, not fasciculate	Averaging about 10×1.5 mm., comparatively narrow, fasciculate in clusters of 2 to 6.
Pedicels	4-5 mm. long	2 mm. long or less
Nutlets	Slender, acute, $6-8 \times 2.5$ mm.	Stout, rounded, 6×3 mm.

Among specimens borrowed from the Arnold Arboretum, Harvard University, all of which had been identified tentatively as *F. angustifolia*, were five which appeared closely related to *F. texana*. One of these specimens (collected January 25, 1934, in Zapata County, Texas, *Elzada U. Clover 1685*) in sparse foliage only, the leaves are almost linear, up to 4 cm. long and 3 mm. broad, and somewhat acute at the apices instead of being broadly rounded. This specimen appears to merit distinction as a variety or form under *F. texana*, but more ample material is needed before any decision can be reached. The other four specimens, it seems to the writer, represent an entity worthy of description at this time as a variety of *F. texana*. Because of the close association of Ernest J. Palmer in the collection and study of this material, I take pleasure in dedicating this variety in his honor.

FORESTIERA TEXANA var. **Palmeri** var. nov. A forma typica differt foliis confertioribus, brevioribus, arctioribus, verticillatim dispositis; folio hujus varietatis typico 1.5 cm. longo, vix vel haud 3 mm. lato; fructu cum formae typicae congruit.

This variety differs from the species in its denser foliage and its shorter and narrower leaves averaging 15 mm. in length and less than 3 mm. in breadth and usually borne in clusters; fruit similar to that of the species.

Type. Val Verde County, Texas, June 29, 1917, *Palmer 12372* (Arnold Arboretum).

Other specimens seen. Texas. La Salle County, March 17, 1917, *Palmer 11307*; Uvalde County, June 20, 1917, *Palmer 12319a*; Live Oak County, July 11, 1935, *H. B. Parks (Cory 14885)*.

The remaining specimens borrowed from the Herbarium of the Arnold Arboretum seem to be distinct from each other and from the species and varieties already described. Rather than to propose naming these as new, I prefer to give only collection data

and brief descriptions in the hope that subsequently either I or other collectors will have an opportunity to make adequate studies to determine their status.

1. Brewster County, Texas: shearing pens, Chisos Mountains, July 12, 1932, *C. H. Mueller*. This material lacks fruit, but there is some similarity in size and arrangement of leaves to *F. angustifolia*, from which this specimen differs in its grayish bark and foliage, in its greater density of foliage, and in its leaves all being cuneate at their bases, and in their upper surfaces being minutely hirtellous.

2. Maverick County, Texas: Eagle Pass, *V. Havard*. In all probability this specimen was collected prior to 1885. It has more nearly the foliage of *F. angustifolia* than of *F. texana*. I have seen it in the vicinity of Eagle Pass, but since the plants were regarded as being the former species they received no special attention. Plant a shrub; bark light to dark brown; leaves cuneate-oblong, obtuse, 10–18 mm. long, 1–2 mm. broad, more or less fasciculate, glabrous, subsessile; fruit oblong, about 6 mm. long and 4 mm. thick; nutlet relatively short and thick, about 5 mm. long and 3 mm. thick, rounded at base, blunt at apex, concavo-convex in one profile and at right angles thereto somewhat ovate.

3. Cameron County, Texas: Point Isabel (now Port Isabel), April 8, 1931, *Susan Delano McKelvey* 1779. This differs from all other material of this study in its small, subglobose fruit. Bark grayish; branchlets slender; foliage dense; leaves oblong-cuneate, 1–2 cm. long, 3–4.5 mm. broad, mostly in clusters of 2 to 4, glabrous, short-petiolate, porulose; fruit subglobose, about 4 mm. in diameter, borne on a pedicel 4–4.5 mm. long; nutlet plump, somewhat longer than broad, one face flattened, both ends broadly rounded, less than 4 mm. long and about 3 mm. thick.

4. Mexico: San Miguel, April 14, 1887, *C. S. Sargent*. It is likely that the locality is San Miguel el Grande in Central Mexico, 40 miles west of Guanajuato. The foliage in this species is similar to that of *F. angustifolia*, but its short, ovoid fruits differ from those in all of the other material in this study. Fruiting branches sparingly leafy; leaves 10–15 mm. long and 2–3 mm. broad, glabrous, spatulate, cuneate, porulose, usually borne in clusters of two or more; fruit ovoid, about 5 mm. long and 4 mm. thick, borne singly or in clusters of 2 to 4, on pedicels 3–4.5 mm. long; nutlet short and broad, ovoid, about 4 mm. long and 3 mm. thick.

With the exception of the specimens referred to *F. texana* var. *Palmeri*, all of the material from Texas seen in this study comes from along the Rio Grande. This complex of forms or species apparently stems from a center somewhere in Northern Mexico and its distributional and variational pattern affords opportunity for an interesting study.

I wish to express grateful appreciation to the following members of the Arnold Arboretum staff,—to Dr. A. C. Smith, Curator of the Herbarium, for the loan of specimens, to Mr. Ernest J. Palmer for reviewing my study, and to Dr. Leon Croizat for valuable assistance given me in the preparation of the Latin descriptions in this manuscript. I wish, also, to express gratitude to Mrs. E. J. Walker of La Joya, Hidalgo County, for the excellent material of *Forestiera texana* which she sent to me.

Texas Agricultural Experiment Station,
Substation 14, Sonora, Texas,
March, 1944.

REVIEWS

The Flowering Plants and Ferns of Mount Diablo, California. By MARY L. BOWERMAN. Pp. xi + 290, frontis. + 26 figs. Gillick Press, Berkeley, California, 1944. \$3.75.

Miss Bowerman's intensive survey of the flora of the Mount Diablo region of central coastal California is divided into two sections: first, an introductory discussion dealing with physical factors, concepts and descriptions of plant communities, and floristic relations, and second, an annotated catalogue of the vascular plants.

The catalogue constitutes the main contribution of Miss Bowerman's book. The accounts of species contain data on habitat, altitudinal range, abundance, period of blooming, associates, and local distribution. Keys to families, genera, and species are included, as are also bibliography, glossary, and index. To an ecologist interested in plant-animal interrelations, this catalogue is the best kind of guide to a local flora and provides sound groundwork for evaluation of such interrelations. Those accounts dealing with dominant species, such as the oaks, are especially significant. The factual information appears clearly set forth and constitutes a valuable storehouse of data for plant geographers and systematists.

Attention is here directed to the section of Miss Bowerman's book dealing with ecological aspects of the vegetation, occupying pages 17 to 63, and consisting chiefly of descriptions of plant aggregations of several orders, listed as formations, associations, and societies, together with observations on succession in woodland, grassland, and chaparral. These descriptions and observations are relatively brief and entirely qualitative; they are thus of a preliminary character. Commendable reserve is shown in the treatment of this section, as, for instance, in the use of only the three community terms mentioned above without any attempt to distinguish successional from climax units. Further, the author points out that plant communities of the Coast Ranges are unusu-

ally variable and that "many areas need to be described before synthesis into larger groups can be satisfactorily completed." I share the author's opinion that ecological investigation of Californian vegetation has lagged, and my own comments are an attempt to reinforce and extend the many interesting questions brought up by her survey of the plant communities of Mount Diablo.

To analyze any plant-animal community and its present-day as well as historical relations, investigators are obliged to sample it at many points and to evaluate the contents of all areas occupied by the community in terms of its distributional metropolis. How, for instance, does the *Quercus agrifolia*-*Aesculus* Association of Bowerman fit into the larger picture of the broad sclerophyll formation along the coast from Mendocino County south at least to Los Angeles County? Bowerman's main discussion is understandably confined to the Mount Diablo region, but at times this needs emphasis. Thus, she rejects Cooper's designation of the *Quercus agrifolia*-*Arbutus* Association and states (p. 22) that "*Aesculus* . . . is more characteristic than *Arbutus Menziesii*." She means, of course, that this is true in the Mount Diablo region. If we refer to Cooper (Carnegie Inst. Publ. 319, 1922: 23), we find him quite cognizant of variance: "The characteristic tree is *Quercus agrifolia*. *Arbutus* . . . is next in importance, but *varies greatly in abundance* in different localities. *Aesculus* . . . *is usually prominent*, and *Umbellularia* . . . is equally so." (Italics mine.) I cite this as a fairly typical example of the futile sort of disagreement that appears in papers dealing with community ecology. Each investigator's ideas, impressions, and conclusions are of course colored by the area with which he is most familiar; obviously, what is strikingly true in a local portion of one association may or may not be true over the remaining geographic area of that association. Yet this is overlooked. Miss Bowerman's association may represent a faciation in the larger unit of Cooper.

Other questions come up concerning the community units: (1) The occurrence of *Pinus Coulteri* on Mount Diablo is marginal; its plant associates are in part drawn from, for instance, the *Quercus agrifolia*-*Aesculus* Association. Just what the status of this pine community is in relation to the main geographic area of *P. Coulteri* still remains to be determined. One wonders whether the patch of Coulter pines on Mount Diablo, relatively insignificant from a strictly ecological point of view, should rank there as an association. (2) Bowerman recognizes a broad sclerophyll formation and a deciduous oak-conifer formation. Shall we add a third equivalent unit from the Californian flora, a broad sclerophyll-conifer formation, such as occurs on the eastern slopes of the Sierra Nevada in Inyo County? These seem to me more logically lumped into one woodland formation. The author's own placement of the *Quercus Wislizenii* Association into the deciduous oak-

conifer formation (p. 27) is a sample of the sort of inconsistency that results when several woodland formations are recognized. The fundamental question here concerns the concept of formation, and admittedly this is not clarified easily using as an example the woodland which, in its climax form, contains narrow sclerophylls, broad sclerophylls, and deciduous species. (3) When the author states (p. 20) that "associations . . . differ from each other floristically," she surely means this only in a partial sense, as the associations of, for instance, the chaparral formation differ ecologically as well.

We may profitably ask ourselves, what in the last analysis does the plant ecologist investigate? From one point of view, the answer is growth-form or life-form. Investigations may be directed toward descriptions, factor relations, community interrelations, or succession, but whatever the approach, it seems to me that mainly we study the vegetational mass, the physiological character of its dominant and subordinate species, and the environmental forces leading to particular responses as reflected in life-form. Miss Bowerman suggests this point of view when, in discussing indicator species (p. 17), she states that "even more important than the actual species is the facies of the vegetation." To differentiate kinds of vegetation in terms of facies, or physiognomy, we have used the concept of formation. Underlying this concept are three important considerations: dominant life-forms of the vegetation, their reflection of the nature of habitat, and their influence on the nature of interspecific relations—all obviously fundamental considerations. It is therefore surprising to read here (p. 19), as part of a general discussion of distributional units, that "in some areas the life-zone [or climatic zone] may represent a more fundamental unit than the formation." On Mount Diablo, Miss Bowerman finds the climate fairly uniform; she emphasizes that there physiographic factors strongly influence the vegetation. But to argue that "the placing of woodland, grassland, and chaparral [all present on Mount Diablo] into different formations separates them artificially" seems to me to confuse the reader as to the bases of plant-ecological inquiry. The fact that three different formations occur within one climatic zone is no argument for minimizing the significance of the concept of formation. If in the course of the complex history of Californian vegetation one climatic zone comes to support such diverse, dominant, and apparently climax plant types, we have a situation which offers an exceptional challenge for analysis; we cannot dispose of it by simply applying the term "Upper Sonoran Zone."

Only brief comment can be added on one other problem of a general character touched upon by Miss Bowerman: A discussion of indicator species (p. 17) closes with the interesting statement that "Transition[-Zone] species are not associated one with another on Mount Diablo, nor are they confined to one part of the

mountain." Californian botanists have long been concerned with "indicator" species, and critical analyses such as Miss Bowerman's may place this concept into better perspective among fundamental problems of ecology.

Especially to those familiar with the Californian flora, Miss Bowerman's descriptions and discussions of Mount Diablo plant communities should prove provocative. This part of her work augments the value of the catalogue and floristic analysis. The book is attractively printed and bound; the photographs are well reproduced. Altogether Miss Bowerman's work represents an important, useful contribution, the merits of which will be appreciated increasingly as other local Pacific Coast floras are analyzed and correlated.—FRANK A. PITELKA, Museum of Vertebrate Zoology, University of California, Berkeley.

NOTES AND NEWS

TWO *CARICES* NEW TO MONTANA. Two sedges collected in 1941 in the Vigilante Experimental Range, Madison County, Montana, a branch of the Northern Rocky Mountain Forest Range and Experiment Station of the United States Forest Service, were identified by F. J. Hermann who suggested that they were new to Montana. Specimens herein cited are filed both in the United States Forest Service Herbarium in Washington, D. C., and in the United States National Arboretum Herbarium, Bureau of Plant Industry, Soils and Agricultural Engineering, Beltsville, Maryland.

CAREX EBENEA Rydb., according to Mackenzie (Cyperaceae, in North American Flora 18: 1-472. 1931-1935), occurs in "mountain meadows, Wyoming to Utah, and southward to New Mexico and Arizona." The type was collected on Pike's Peak, Colorado. The Montana specimens were collected in moist "springy" muck in a mountain meadow at 8000 feet elevation, approximately 1500 feet below true climatic timberline (*Lemon* and *Evanko PL-120*). Plants 1.5 to 2.5 dm. tall were relatively common here and flowered in June.

CAREX EPAPILLOSA Mackenzie is given (op. cit.) as occurring in "mountain meadows, Wyoming to Washington, and southward to Utah and California." The type was collected in Utah. The Montana specimens were collected at 9000 feet elevation, about 500 feet below true climatic timberline, in moderately moist, gravelly loam in subapine grassland (*Lemon PL-162*). Plants 3 to 6 dm. in height flowered in July. This species was associated with *Festuca idahoensis* Elmer and species of *Sieversia*.—PAUL C. LEMON, Appalachian Forest Experiment Station, United States Forest Service.

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ERRATA

- Page 59, line 40: for *Harvardi* read *Havardi*.
 Page 67: delete lines 28 and 29.
 Page 81, line 22: for *angustifolia* read *angustifolia*.
 Page 82, line 28: for *Navarratia* read *Navarretia*.
 Page 142, line 38: for *Bulb with rice-grain bulblets* read *Bulb of several scales*.
 Page 142, line 41: for *Bulb of several scales* read *Bulb with rice-grain bulblets*.
 Page 148, line 45 and throughout paper: for *folcata* read *falcata*.
 Page 151, symbol for *Fritillaria recurva* var. *coccinea* should be an open triangle instead of a solid triangle.

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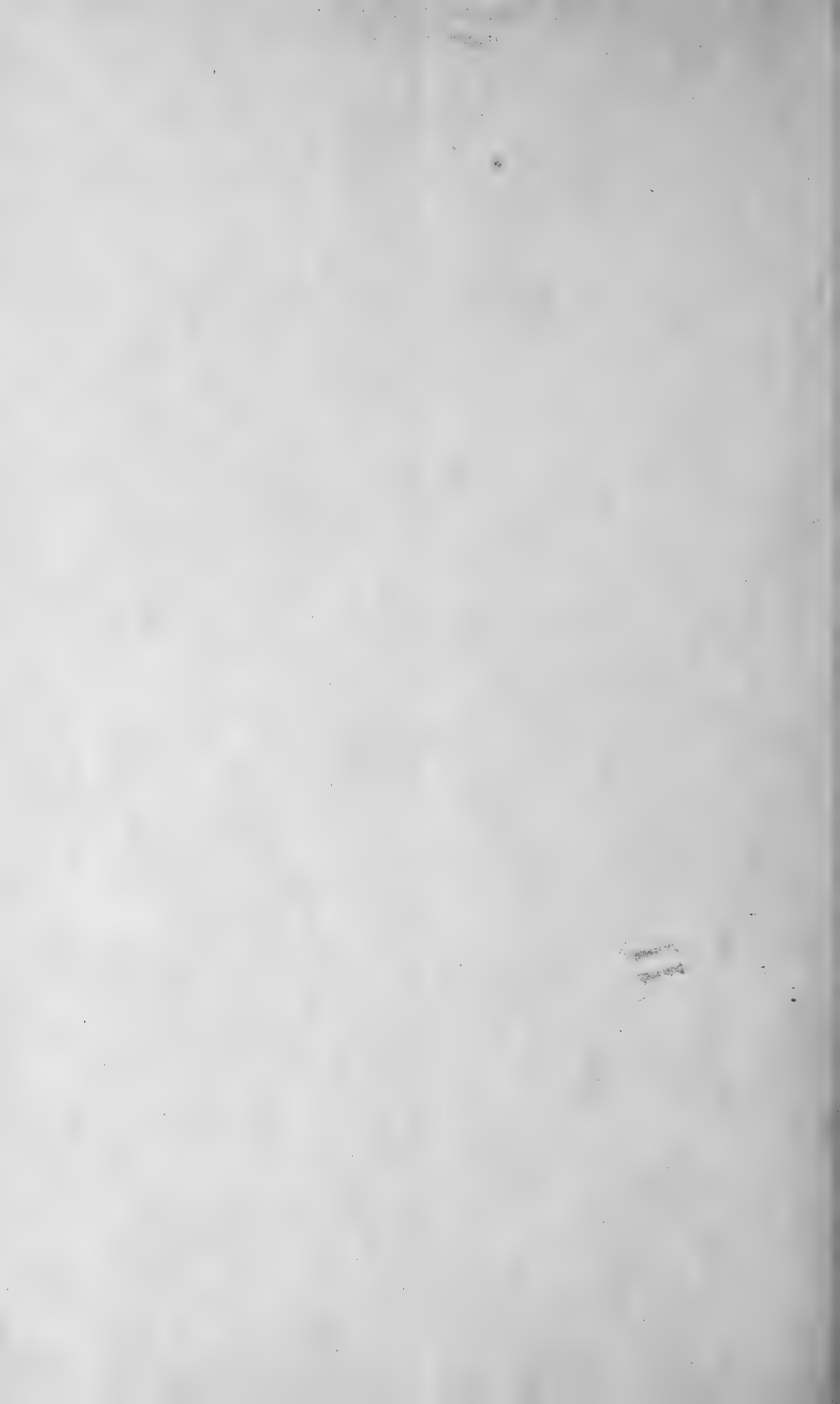
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